Chapter One

Introduction

1.1 Background to the Study

The most important concern of our day is the widening of income inequality. It is crucial to remember that both developed and developing nations are affected by this issue, making it a global issue. The wealth disparity in leading economies is at its highest point in decades[1]. Inequality trends in Emerging Markets and Developing Countries (EMDCs) have been more varied, with some nations enjoying reduced inequality, but enduring gaps in access to finance, healthcare, and education still exist[1]. The degree of inequality, its causes, and solutions have thus become some of the most highly contested topics among lawmakers and researchers alike[1].

For the most part income inequality between countries had improved in the last 25 years, meaning average incomes in developing countries are increasing at a faster rate[2]. This can be attributed to the rapid economic expansion of China and other growing Asian economies. The disparity between nations is still substantial, though. As an illustration, the average income in North America is 16 times more than that in sub-Saharan Africa. Despite improvements in wealth disparity across nations, intra-national disparities have been worse[2]. Currently, 71 percent of the world's population resides in nations with rising inequality[2]. This is very crucial because inequalities within countries are the inequalities people feel day to day, month to month, year to year. This is how people rank and contrast themselves with their friends, relatives, and the rest of society. In most affluent nations as well as several middle-income nations like China and India, income disparity has risen since 1990. Over the past three decades, inequality has increased in the majority of nations, but it has decreased in a few. Trends in Africa and Asia have been more diverse, with similarities between developing

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nations that are landlocked or emerging economies as well as rural or urban areas being larger than within regions.

The fundamental cause of income inequality is the unequal distribution of individual's employment benefits, which vary based on productivity, entrepreneurship, and other factors such as educational attainment. The concentration of income and wealth in the hands of a small number of people can be a good thing, leading to the creation of new firms and more investment in education, particularly in emerging nations. However, income inequality can have a negative impact on certain social groups and be a result of a lack of opportunity. The effects of excessive inequality might include social conflicts, increased crime, political and economic instability, and poverty. Governments, politicians, international organizations, multinational corporations, stakeholders, academicians, etc. have all paid attention to the issue of large and expanding income inequality, which has led to scientific research and developing policy concerns.

Among the factors responsible for incessant rise in income inequality in the body of literature are economic instability (resulting from low per capita income, inadequate investment, high inflation, low labor participation rate, education etc.), financial crisis, low credit facility, debt, social disorder, political instability, government policies, among others. Likewise, the following factors of economic inequality are identified by past studies: (a) technology as it alters the nature of work by creating enormous wealth for people with these skills while eliminating the jobs of semi-skilled workers; (b) rules changes and violation by political elites – political powers gained through increasing wealth further allowed economic gainers to compensate themselves via government policies; and ultimately, (c) globalization as it raises competition coupled with low trade barriers from the advanced and emerging economies like United States, Germany, Canada, United Kingdom, France, Italy, Japan, China, India, etc. which have curtailed the economic prospects for the developing countries[3].

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For instance, a study which looked at how globalization affected developing nations' economies argued that these nations should be cautious and closely watch the flow of foreign direct investment because the negative effects cannot be disregarded[4].

Growth is positively impacted by capital inflows when the recipient nation's institutions are of high quality[5]. In developing countries without the necessary structures to monitor the changes in the many sectors of their economies, FDI has the potential to both dominate local entrepreneurship and generate jobs in the local market. Because of their ties to Multinational Corporations (MCNs), emerging countries notably the Oil-Developing Countries (ODCs), suffer from a natural resource curse. The MNCs' unscrupulous business practices have made it difficult for the ODCs to fully capitalize on their endowment of natural resources[6]. Therefore, the Heckscher-Ohlin Factor Endowment Theory of International Trade is threatened by globalization. The failings of globalization are the root cause of the trade conflicts and tariff increases between the US and China[7]. Anti-globalization attitudes have grown because of the unequal trade between rich and developing nations, as seen in the Brexit vote and the 2019 US midterm elections. Globalization may lead to dumping, hinder local skill development, and transfer risk to developing nations with low-risk management systems[8].

Nevertheless, it is important to know that globalization has also profoundly impacted our way of life. It has improved innovation, accelerated access to technology, and boosted communication[9,10]. It has ushered in a period of increased economic prosperity, opened vast new avenues for development, and been crucial in bringing people from various cultural backgrounds together.

On the other hand, globalization has given rise to several problems, the most notable of which is its impact on the environment[11]. Environmentalists have made globalization a major topic in environmental discussions by highlighting its extensive effects. But as wealth

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increases, so does ecological awareness, which acts as the central justification for reducing environmental harm in later stages of economic growth[12].

Various chemicals have been added to the soil because of globalization and industrialization, resulting in many noxious weeds and plants. This toxic waste has seriously harmed plants by altering their genetic composition[13,14]. The readily accessible land and water resources have been strained by this. Mountains are being chipped away in numerous locations to make room for a motorway or tunnel that will pass through them. Large portions of desolate land have been violated to build new structures[15]. These developments might draw people in while also having negative effects on the environment. Plastic, a non-biodegradable substance, has been identified as one of the most harmful pollutants in numerous studies[16,17].

However, plastic is incredibly helpful for export packaging and preservation of products. As a result, the use of plastic has increased dramatically, leading to extensive contamination. Numerous studies have been done in this area, including those on economic complexity[18,19], export diversification[20,21] and trade[22]. On how to best measure globalization's impact on environmental degradation in developing countries like Economic Community of West African States (ECOWAS), researchers are divided in the body of literature.

World leaders from both developing and developed nations have obliged to end poverty and preserve a healthy environment for coming generations[23]. By promoting industrialization and production levels, developing countries in particular encourage their economic activities to strengthen their economies and reduce poverty. However, economic activities meant to promote economic growth also increase the need for energy, which increases carbon dioxide (CO_2) emissions and harms sustainable development[24]. Economic growth can help reduce poverty, especially if it is not associated with worsening income inequality and environmental damage. Numerous studies that have investigated the relationship between income and CO_2 emissions have suggested that, at some point, an increase in income

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degrades the environmental quality. From the perspective of developing nations, income may ultimately result in less poverty but more environmental concerns[25]. The SDGs are observed to be more attainable in developing economies than in developed economies. We have focused on countries in ECOWAS because they continue to face challenges in boosting their economic development, eliminating poverty, addressing income inequality, and improving the standard of living for those who are less fortunate. The current energy supply structure in ECOWAS is based on fossil fuels, which causes high energy consumption and consequently high CO_2 emissions[26]. This is a result of economic activities aimed at reducing poverty.

Although countries in Sub-Saharan Africa region did not rank among the top emitters of carbon dioxide in 2019 and only consumed about 4.9% of the world's total energy, the region's anticipated economic growth is closely correlated with high energy demand, with a 3.8% annual increase from 2000 to 2017[27]. Sub-Saharan Africa saw a significant increase in 2014, with 822,819.03 kilotons of CO_2 measured, which is 4.94% more than in 2013[27]. Given that most of the countries in the region are highly sensitive and lack the resources to mitigate the effects of the environment, the potential environmental deterioration could have a significant negative impact on the region[27]. It has been stated that Sub-Saharan Africa will likely experience highly severe effects from climate change as a result of economic activity[28]. Although the economies of Sub-Saharan Africa are slowly improving, they remain among the world's poorest region. It is also noted that, depending on the situation, Sub-Saharan Africa's poverty may not be eradicated by the year 2030; but it can be reduced through economic development and a just distribution of wealth among the socially disadvantaged. It is significant to note that due to rising inequality, half of the Sub-Saharan African countries were unable to meet the poverty reduction and Millennium Development Goal (MDG) targets[29]. Despite efforts to reduce poverty, 45% of the countries in the region still experience extreme poverty, a lack of basic services like clean water, health care, and education, as well

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as incomes of less than US$1.9 per day[23]. Four hundred and thirteen million people still live below the poverty line[28], even though poverty has been on the decline since 1990. In terms of inequality, Sub-Saharan Africa has a higher Gini coefficient than the rest of the developing world (0.43), indicating that inequality there is extremely high[30].

Due to their severe vulnerability, the poorest members of society are those who suffer the most from an unequal distribution of wealth. In addition, wealth disparity drives up emissions by impeding the implementation of environmental regulations. Additionally, it can result in a reduction in environmental protection and ultimately result in higher emissions. Furthermore, it is asserted that voting and ownership channels contribute to rising emissions[25] due to income disparity.

According to a large number of environmentalists, globalization promotes demand for products and services globally, which in turn boosts economic activity and productivity. This causes both environmental damage and the depletion of natural resources. Researchers have also discovered that globalization has detrimental environmental externalities[30].

1.2 Statement of the Problem

Among the major macroeconomic objectives of every nation are fair income distribution and sustainable economic growth and this has led to the emergence of different policy measures to ensure the objectives are achieved. In ECOWAS however, income inequality within countries have been consistently high with-it attendant effects on the most vulnerable. There has been an upward trend in income inequality rate and a persistent and large variation in equitable distribution of income during the period under review and this has impended the credibility of the different policy measures.

Despite the joint efforts of the government, World Bank, IMF, and other multinational corporations in implementing policies aimed at reducing income inequality and fostering

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economic growth, the economy of countries in ECOWAS have been experiencing 'within' increasing income inequality. The countries are still experiencing increasing rate of unequitable distribution of income over the past decade regardless of the frequent interventions of the World Bank, IMF, and other multinational corporations. These indicate that there is still a point of disconnect between the several policies that the policy maker pursues and the outcome of the policy objectives. This has resulted in the interrogation of the policy framework and its instruments on whether they can deliver the equitable income distribution in ECOWAS.

Although, income inequality is a worldwide phenomenon, whose rate, and effects, vary from country to country the problem is more pronounced in developing countries such as ECOWAS region[1]. The income inequality trends in ECOWAS region have constituted one of the devastating problems since late 1990s. Notwithstanding the enormous research, most researchers and policy makers remain divided on the appropriate policy instruments, targets, and framework. This follows enormous divide in empirical findings on the subject.

The question arising then is that, does globalization positively or negatively affect environmental sustainability? Then, is it possible to reverse the adverse effects of globalization on environmental sustainability such that globalization positively affects environmental sustainability whilst exerting a significant effect on income inequality? Understudying these questions provide policymakers ways of implementing policies using tools that will be effective in controlling income inequality whilst reducing the adverse effects of globalization on environmental sustainability.

To address these issues, this study attempts to examine the major policies that are being used by the government and policymakers in ECOWAS region to control the adverse effect of income inequality and investigate which policy tool is effective in curbing the dangers of globalization, and income inequality in ECOWAS.

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1.3 Research Questions

This research study addresses the following questions:

1. In what way does globalization affect environmental sustainability in ECOWAS?
2. How does globalization affect income inequality in ECOWAS?
3. What is the effect of environmental sustainability on income inequality in ECOWAS?

1.4 Objectives of the Study

The aim of this study is to examine the relationship among globalization, environmental sustainability, and income inequality in ECOWAS. The specific objectives are to:

i. examine the effect of globalization on environmental sustainability in ECOWAS:

ii. examine the effect of globalization on income inequality in ECOWAS; and

iii. determine the effect of environmental sustainability on income inequality in ECOWAS.

1.5 Hypotheses

The study tests the following hypotheses:

H_{01}: Globalization has no significant impact on environmental sustainability in ECOWAS.

H_{02}: There is no significant relationship between globalization and income inequality in ECOWAS.

H_{03}: There is no significant relationship between environmental sustainability and income inequality in ECOWAS.

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1.6 Scope of the Study

This study seeks to add to the existing body of literature by examining the effects of globalization, environmental sustainability, and income inequality in ECOWAS region from 1996 to 2019. This period is imperative as it shows the increased trends of income inequality in most countries over the past two decades, while few has fallen. In Africa and Asia, the trends have been more varied, with greater similarities between emerging economies or landlocked developing countries, and between rural or urban areas, than within regions. To achieve this, the study uses data from period 1996 to 2019 for the 15 ECOWAS countries, that is: Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Guinea Bissau, Ghana, Liberia, Mali, Niger, Nigeria, Guinea, Senegal, Sierra Leone, and Togo. Thus, the study is panel in nature.

1.7 Significance of the Study

This study aims at contributing to the existing body of knowledge on globalization, environmental sustainability, and income inequality in ECOWAS. On macroeconomic level, one of the responsibilities of the government of each country in ECOWAS is to generate policies that will increase output and productivity, while preserving the environment for future use as well curtail the excessive concentration of wealth among certain people whilst leaving the masses to suffer.

The findings of this study will provide significant information for the government in ECOWAS, policy makers as well as multinationals such as International Monetary Fund (IMF) and World Bank to identify more effective policies that will be imperative in sustaining the environment for future use and more importantly reducing income inequality to the barest minimum.

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This study will view globalization from an eclectic view incorporating various aspects of globalization such as economic (trade openness), financial (inflows from foreign direct investment), political (democratic), technology etc. By using trade openness, financial openness, and KOF globalization index as a proxy for globalization as opposed to most research work that viewed globalization only from a trade perspective and used trade openness as a proxy for globalization.

Environmental sustainability will also be proxied by using carbon emission and ecological footprints as opposed to most research that only took into cognizance the use of carbon emission as a proxy for environmental sustainability. Income inequality on the other hand will be proxied by using Gini coefficient respectively. This study is of great importance because, despite various policies adopted by the government, there is still an increasing growth of income inequality within countries in ECOWAS.

The study is also significant to academicians and researchers who want to understand the relationship that exist among globalization, environmental sustainability, and income inequality in ECOWAS, increase their knowledge base and identify gaps that require further research and instruments that can be used to offer quality research.

1.8 Operational Definitions of Terms

Carbon Emissions: Carbon dioxide emissions, also known as CO_2 emissions, are emissions caused by the combustion of fossil fuels and the production of cement; they include carbon dioxide emitted during the consumption of solid, liquid, and gas fuels, as well as gas flaring.

Ecological Footprint: The cumulative area of land needed to sustain an activity or population is referred to as an ecological footprint. It likens how quickly we consume resources and generate waste to how quickly nature can absorb our waste and generate

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resources. It considers environmental factors such as water consumption and the amount of land used for food production.

ECOWAS: It is a regional political and economic union of fifteen West African countries, including Benin, Burkina Faso, Cape Verde, Cote d'Ivoire, Gambia, Guinea Bissau, Ghana, Liberia, Mali, Niger, Nigeria, Guinea, Senegal, Sierra Leone, and Togo. These countries cover a total area of 5,114,162 km^2 and have a population of 422,831,039 people as of July 2022.

Environmental Sustainability: Environmental sustainability is defined as responsible interaction with the environment to avoid natural resource depletion or degradation and to allow for long-term environmental quality. Environmental sustainability helps to ensure that the needs of today's population are met without jeopardizing future generations' ability to satisfy their own needs.

Globalization: Refers to the increasing interdependence of the world's economies, cultures, and populations as a result of cross-border trade in goods and services, technology, and flows of investment, people, and information. It has to do with how the economies of different countries work, especially the growth of trade, the opening of global supply chains, and the sharing of natural resources and labor markets.

Income Inequality: It is defined as unequal levels of income among members of different groups, such as between individuals in the same country or between countries. The more unequal the distribution, the greater the income inequality. Wealth inequality, or the unequal distribution of wealth, is frequently associated with income inequality.

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Chapter Two

Literature Review

This section presents the review of related concepts, theories, and empirical studies on globalization, environmental sustainability, and income inequality in ECOWAS. Specifically, this section conceptualizes globalization, environmental sustainability, and income inequality. Also, theories and empirics related to the topic of the study were discussed. Lastly, the gaps in literature were identified.

2.1 Conceptual Review

2.1.1 Globalization

Globalization is certainly quite a vague term but can be defined as "the trend for people, business, and governments over the world to become largely dependent on and incorporated with each other[1]. It is a term used to describe how trade and technology have connected and interlinked the world. Globalization can also be identified as the spread of ideas, knowledge, information, goods, and services throughout the world. Globalization contributes to economic growth (via market processes), but it also increases inequalities, both between and within various regions[1]. While globalization may limit nation states' maneuverability, their adaptation strategy retains some autonomy. It can be linked to the threads of a massive spider web formed over millennia, with the number and reach of these threads increasing over time. People, money, material items, ideologies, and even disease and devastation have travelled these silken strands in greater numbers and at a faster rate than ever before in history. In the context of business, the phrase refers to integrated economies with open trade, unrestricted capital movement among nations, and simple access to foreign labor markets to increase profits and advance the common good. Alternatively, globalization could be functionally defined by an intrinsically linked set of economic phenomena. These include market

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liberalization and deregulation, asset privatization, the retreat of state functions (particularly welfare functions), technology diffusion, cross-national distribution of manufacturing production (foreign direct investment), and capital market integration. At its most basic, the term refers to how sales, manufacturing facilities, and manufacturing processes are spread around the world. Together, these things make up the international division of labor.

Economic globalization is the term used to describe how interdependent the world's economies are becoming because of greater cross-border trade in goods and services, the movement of capital across borders, and the wide-spread and quick adoption of new technology. At the turn of the millennium, it represents the continual growth and reciprocal integration of market borders and is an unstoppable trend for world economic progress. Marketization and the fast-rising relevance of information in all forms of productive activity are the two main forces behind economic globalization other words, the recent rapid globalization of the world's economies is largely due to the rapid development of science and technology.

Globalization Indicators

There are two major indicators of globalization which includes international product movement and international factor mobility[2]. The former refers to free trade in both imports and exports, whereas the latter refers to the movement of productive inputs such as labor, capital, technology, and even entrepreneurship across borders. Imports are goods or services produced in another country but brought into the country, whereas exports are goods or services produced in the country but sold to another country. Internal trade includes imports and exports. When there are cost differentials, imported goods or services are appealing, and free trade agreements and tariff schedules frequently specify the composition of imports. Economists and policy analysts disagree about the benefits and drawbacks of imports. Exports are critical to economies because they expand both factor and product markets for

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people, businesses, and even the government's goods and services. In 2019, the top exporting countries were reported to be China, the United States, Germany, the Netherlands, and Japan[3]. Foreign direct investment is the ownership of business interests in another country by an individual or firm from one country. It entails providing capital, management, and technology for an overseas business establishment to use. This is distinct from foreign portfolio investment, which is simply the provision of equity capital to foreign companies[4]. All of these are indicators of an economy's openness, which is referred to as globalization. Another indicator of globalization is the number of minutes spent on international phone calls. The recent Twitter ban imposed by the FGN is a setback for globalization because it will impede the aggressive growth of the technology sector, which has seen significant investment and contributed to GDP, and a restrictive policy will have a long-term impact on the economy of the country and the subregion at large[5]. The ban has a negative impact on globalization because it has harmed both trade and diplomatic relations.

The Effects of Globalization

Scholars investigated the globalization-growth nexus and discovered that, depending on the political context, there is a positive relationship between economic globalization and economic growth[6]. The author used panel data from 83 countries to discover geographical and institutional spill overs of globalization. Globalization can have an impact on growth and can be transferred to other economies depending on the policies in place. However, globalization has reduced West African countries to primary product exporters and final product importers[7]. International trade produces winners and losers; however, if nothing is done to compensate the losers, total joint productivity will eventually fall. Concerning the relationship between globalization and economic growth. Economic and political globalization have both been found to positively affect economic growth in Romania, while social globalization has been found to negatively affect economic growth[8]. However, it

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makes an economy more vulnerable to economic and financial crises[9]. In terms of migration, globalization has both positive and negative effects on both the source and host economies. It destabilizes the source economy by reducing labor supply and the size of the product market. It leads to brain drain. Aside from the numerous non-economic implications, it also exerts pressure on immigration authorities in the host country. Both labor and capital income rise in the host country, as do taxes and pressure on public goods, while remittances to the source country rise as well. However, the net effect is a decline in GDP in favor of the host economy over the source country[10].

Favorable and Unfavorable Impacts of Globalization

Several arguments have been made as to if globalization is beneficial or detrimental to the growth of a country. It is necessary to point out some of the merits and demerits of globalization, some of which are highlighted below:

Favorable Impacts of Globalization are as Follows:

More globalization is typically thought to result in higher economic growth for all stakeholders. This may be the case for a few reasons, including the fact that globalization gives all countries access to a wider labor pool. For instance, developing nations with a shortage of knowledge workers may "import" labor to stimulate the economy. On the other hand, richer nations may outsource low-skill jobs to underdeveloped nations with less living expenses to cut the cost of items sold and pass those savings on to customers. Resource access can also be made easier through globalization. Gaining access to resources that other countries would not have is one of the main motivations behind international trade. Without this cross-border flow of resources, it would be difficult to manufacture or produce many modern luxuries. Smartphones, for example, rely on rare earth metals that are only found in a few places around the world. Globalization allows for a country's specialization. Countries

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can rely largely on their economic capabilities thanks to international and regional cooperation because they know they can exchange their products for other resources[11]. As an example, consider a tropical country that specializes in the export of a specific fruit. Trade benefits both parties when nations specialize in the production of goods or services in which they have an advantage.

Globalization encourages more cross-border investment. International investment has been shown to improve welfare at the macroeconomic level. The nation that provided the capital gains because it frequently earns a higher return abroad than it does at home. Because the influx of capital increases investment and, consequently, productivity, the receiving nation also reaps benefits. Foreign investment frequently comes with, takes the form of, or gives access to technological know-how or distribution channels that can help the recipient nation.

Unfavorable Impacts of Globalization are as Follows:

Globalization, when viewed holistically, benefits the entire system. Global competition, on the other hand, can be detrimental to individual businesses, organizations, and workers. This is similar to how these parties may be harmed by domestic competition: Some firms, industries, and citizens may elect governments to pursue protectionist policies designed to shield domestic firms or workers from foreign competition. Common types of protectionism include tariffs, quotas, and non-tariff barriers, such as quality or cleanliness regulations. These types of barriers make it more difficult for rival nations or businesses to justify doing business in the country. These attempts almost always end up being counterproductive to the overall economic success of both parties.

In addition, globalization can result in uneven economic development not only across states but also inside individual nations. These repercussions require vigilant administration from a financial and ethical standpoint respectively. Many times, the result of globalization is an

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increase in the amount of immigration that occurs within countries. Immigration has been shown to increase a nation's gross domestic product (GDP), which is a measure of overall economic activity. This can be of significant advantage to the nation that is the recipient of immigration. On the other hand, in the short run, immigration may result in a lower GDP per capita if the average income of immigrants is lower than the average income of those who are already residing in the nation. Finally, increased globalization has been linked to a variety of serious environmental challenges, including deforestation and biodiversity loss associated with specialization of the economy and the development of infrastructure, emissions of greenhouse gases and other forms of pollution caused by increased transportation of goods, and the introduction of potentially invasive species into new environments are some of the issues that have arisen because of globalization.

2.1.2 Environmental Sustainability

The phrase "environmental sustainability" refers to the practice of interacting with one's surroundings in an ethical manner to prevent the depletion or degradation of natural resources and to make way for high standards of environmental quality in the long run. Sustainability in environmental practices helps to ensure that the requirements of the current population are met without risking the ability of future generations to get by with the resources available to them.

Environmental sustainability refers to the duty of preventing damage to human health and well-being both now and in the foreseeable future by conserving natural resources and working to maintain the integrity of the world's ecosystems. As a result, the link between energy, the environment, and sustainable development should be highlighted[12].

Despite numerous efforts to protect the environment, the environmental burden of disease remains high – 13 million deaths are attributed to environmental factors each year[13].

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Furthermore, global challenges such as climate change and energy demand are on the rise, and new threats such as electronic waste and microplastics are emerging. A transformational approach is therefore required to create healthier populations through healthy environments.

A healthy environment is vital for human health and development. Air pollution alone causes seven million preventable deaths per year, with more than 90% of people breathing polluted air and nearly three million people still relying on polluting fuels such as solid fuels or kerosene for lighting, cooking, and heating[14].

More than half of the world's population is still exposed to contaminated water, inadequate sanitation, and poor hygiene, resulting in over 800,000 preventable deaths each year. A large proportion of malaria cases and other vector-borne diseases are linked to environmental management and manipulation, such as drainage, irrigation schemes, or dam design. Every year, over one million workers die because of unsafe working conditions, and over one million people die because of chemical exposure[15].

When we look at the natural world, we see that it has a remarkable capacity for self-renewal and survival. For instance, when a tree falls, its decomposition enriches the earth with nutrients. These nutrients aid in maintaining ideal conditions for the continued growth of young saplings. When left alone, nature is incredibly capable of taking care of itself. However, when man enters the picture and utilizes many of the natural resources that the ecosystem provides, things change. Natural resources can be depleted by human activity, and if environmental sustainability techniques are not used, long-term viability may be compromised.

Environmental sustainability is defined by the United Nations (UN) World Commission on Environment and Development as operating in a way that ensures future generations have access to the natural resources, they need to live lives that are at least as good as those of

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current generations. The UN's definition, while not universally agreed, is conventional and has been expanded over time to incorporate viewpoints on human needs and well-being, including non-economic factors like education and health, clean air and water, and the preservation of the environment's natural beauty.

Importance of Environmental Sustainability

Business groups can make a significant contribution to environmental sustainability. They must develop a business strategy that will be advantageous to the company while simultaneously promoting environmental safety. Experts agree that social and environmental welfare should be prioritized together with economic progress and that environmental sustainability can be seen as a strong foundation for sustainable development. There is no question that an economy cannot thrive sustainably without taking the environment into account. So, governments and businesses all over the world need to think about this to get better results.

The environment is one of the major policy concerns that has significantly increased in prominence over the past several years. As a result of growing concern over environmental issues, governments all over the world are setting strict pollution targets. As a result, businesses that offer environmental solutions also benefit from cutting-edge market potential.

A delicate balance must be struck between the preservation of natural systems, economic growth, and community cultural and social well-being to preserve environmental sustainability[16]. Environmental sustainability may be quite advantageous for business companies. It will not only lessen negative effects on air, water, and land, but it will also assist them in meeting their legal requirements. Future environmental issues and climate change are being addressed in both developed and developing nations, so it is crucial for businesses to include this idea in their sustainability plans. Businesses, such as PepsiCo Inc.,

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have been pursuing a global strategy for environmental sustainability. In order to lower greenhouse gas emissions and the price of waste and packaging, the corporation has cut back on its use of water and electricity. Striking a balance between sustainable business practices and natural systems is currently necessary for both small and large organizations around the world. Today, a corporation will only be seen as a better business if its operations do not harm the environment. Natural resources should be utilized in a balanced way to satisfy current needs as well as those of future generations.

The Pros and Cons of Going Green

The Pros of Going Green Include the Following:

Saving Energy

One important advantage of going green is that it saves plenty of energy in the long run. Going green implies turning lights and electronic devices off whenever they are not in use or needed. Moreover, the purchase of energy-efficient household devices to make your behaviour even more eco-friendly is encouraged. Energy bills will gradually start to drop dramatically, saving not just a ton of energy but also a ton of money in the long run because energy prices are only going to rise.

Saving Water

Going green will help save plenty of water in day-to-day activities. For instance, using a washing machine as well as a dishwasher that are water-efficient will help to save this precious natural resource. Many people still tend to underestimate the value of water, but as global warming makes water a more limited resource, the true worth of water will eventually become clear.

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Waste Reduction

Another upside of going green is that waste production can be substantially reduced at home. Since waste must either be burned or disposed into landfills, waste production implies serious adverse consequences for our environment. To go green, purchasing things that are not packaged in excessive packaging material is encouraged. A coffee enthusiast is likely to order coffee-to-go and use disposable plastic cups. But using these cups is bad for the environment because it leads to a lot of plastic waste that doesn't need to be there.

Safeguard of Natural Resources

In general, another merit of going green is to safeguard natural resources from exhaustion. Businesses continue to use significant volumes of fossil fuels in several production processes. However, as these resources will eventually run out, this usage of non-renewable resources raises significant difficulties. Since technological progress is heavily dependent on those resources, they must be protected at all costs to assure the supply of those precious resources for as long as possible[17].

Reduction in Deforestation

The reduction of deforestation problems should be taken seriously. Deforestation implies several serious environmental problems, including global warming, habitat destruction, and many more. Therefore, it is crucial to protect our forests. The extraction of natural resources frequently results in deforestation. Therefore, it is urged to cut back on material use and to conserve energy whenever possible because doing so indirectly lessens the problem of deforestation.

Reducing Climate Change

Climate change can also be somewhat slowed down by adopting a green lifestyle. Since several studies have demonstrated that greenhouse gases are one of the primary causes of

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global warming, the problem of global warming can be mitigated by limiting human emissions of greenhouse gases.

Improvements in Overall Health

Going green indicates that individuals are conscious of how their actions and consumption affect both the world and their health because it also entails learning about environmental challenges and their associated negative repercussions. As a result of this advantage in knowledge and awareness, such people will be more eager to consume healthier foods, and their general health tends to be better.

Fewer Fossil Fuels Should be Used.

When turning green, one should steer clear of everything created or manufactured using fossil fuels. Fossil fuel consumption harms the environment because it results in significant greenhouse gas emissions. Also, as the name suggests, fossil fuels can't be made again, so we may run out of them soon.

The Cons of Growing Green Include the Following:

May Require Substantial Initial Investments.

Some environmentally friendly equipment costs a lot of money. For instance, it might not be inexpensive to put solar panels on a roof. The initial costs must thus be financed in some way, and it may be necessary to take out a loan to be able to afford those improvements, even though they may amortize over time.

Potentially Time-Consuming

Going green requires not only a serious commitment, but it can also take a lot of time. For instance, installing eco-friendly equipment may be required. Furthermore, separating waste in a green way can take more time now. As a result, many tasks in our daily lives may take a

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little longer. Even so, it's wise to give it a shot because a promising future for the next generation ought to be worth everyone's extra effort.

The Cost of Organic Items Is Higher.

Purchasing organic rather than conventional food is another aspect of going green. Organic food products are frequently much more expensive, and especially if one is on a budget, one might not be able to afford to switch to organic food at this time, even though those products are generally quite good for our health and protect our farm animals from unsanitary living conditions.

Social Exclusion

Going green could also be very challenging socially, depending on the area. Living sustainably can be difficult if you reside in a region where people are extremely resistant to change and where many stores do not provide environmentally friendly products. Furthermore, if a person does not adhere to regional conventions that in some places suggest eco-unfriendly behaviour, they may even become socially isolated.

In Some Areas, There Could not be enough Green Infrastructure.

The fact that the infrastructure is potentially quite poor for being environmentally friendly is another issue with going green. If you live in a small town, for instance, the likelihood is that the public transit system is rather inadequate, and you may be forced to use your automobile whether you want to or not since you would otherwise be unable to make it to work on time. Going green may sometimes be difficult, especially in isolated areas.

It Could be Challenging to Locate Subject Matter Experts.

Since going green has gained popularity over the past few years, there aren't many industry professionals in this subject, and it may be difficult to get skilled workers who can repair green devices should they malfunction. This might be a major problem, especially in isolated

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rural locations where you might need to learn a lot of information to perform repairs on your own.

Consequences of Global Warming

Global Temperature Increase: By 2050, the Earth's mean temperature is predicted to have risen by 1.5–5.5 °C if greenhouse gas emissions continue to rise at their current rate. The planet would be warmer than it has been in 10,000 years, even if the lower estimate were utilized.

Sea Level Rise: Due to seawater expansion as a result of rising global temperatures Current predictions state that a 3 °C increase in average air temperature will result in a 0.2–1.5m rise in sea level during the next 50–100 years. Sea levels will continue to increase because of the glaciers and polar ice sheets melting because of global warming. Additionally, this will disrupt a few significant commercial spawning grounds and presumably increase the likelihood that storms may harm coral reefs, estuaries, and lagoons.

Effects on Human Health: Changes in rainfall patterns brought on by global warming could affect the transmission of diseases carried by insects, including malaria and elephantiasis. Areas free of schistosomiasis, malaria, and other diseases could develop into breeding grounds for disease vectors. More stagnant water and warmer temperatures would promote the growth of snails, mosquitoes, and other disease-carrying insects. Higher temperatures and humidity will aggravate or worsen respiratory and skin conditions.

Effects on Agriculture: There are several ways to look at how global warming will affect agriculture. It might affect different crops in different places of the world favorably or unfavorably. Tropical and subtropical regions will be more impacted because the average temperature in these areas is already high. For crops, even a 2°C rise might be deadly. As evapotranspiration increases, soil moisture will decrease, posing a major danger to the

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production of wheat and maize. Increases in temperature and humidity will promote the growth of disease vectors and the multiplication of insects. Crops won't be able to adjust to these changes as quickly as pests can. To adapt to the changing environment, various plant species have been produced that are pest-, heat-, and drought-resistant[18]

2.1.3 Income Inequality

The unequal distribution of income across a population is one definition of what is referred to as "income inequality". The income gap widens as unequal distribution brings about greater disparities in pay. Inequality of wealth, also known as an uneven distribution of wealth, frequently occurs hand in hand with income inequality. It is possible to subdivide populations in a variety of ways to illustrate a range of different degrees and types of income inequality, such as income inequality based on gender or race. Different measures, such as the Gini coefficient, can be used to analyze the level of income inequality in a population. The most significant obstacle facing our generation is the continued widening of the income gap. The gap between the wealthy and the rest of the population in developed economies is at its highest point in decades. The trends in inequality in emerging markets and developing countries (EMDCs) have been more mixed, with some countries experiencing declining inequality and other countries continuing to experience pervasive inequities in access to education, health care, and finance. However, some countries have experienced declining inequality. It should not come as a surprise that the level of inequality, the factors that contribute to it, and the potential solutions to the problem have become some of the most hotly debated topics among researchers and policymakers[19]. Equality, much like fairness, is a highly prized principle in many societies. People are concerned about inequality regardless of their ideologies, cultures, or religious beliefs. Inequality can be a sign of limited income mobility and opportunities, which reflects ongoing disadvantage for certain parts of the population. Increasing inequality not only has significant implications for growth and

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macroeconomic stability, but it can also lead to the concentration of political and decision-making power in the hands of a few, result in a less-than-optimal use of human resources, cause political and economic instability that discourages investment, and increase the likelihood of a crisis. The economic and social repercussions of the global financial crisis, as well as the subsequent headwinds to global growth and employment, have brought heightened awareness to the issue of rising income inequality.

The challenge of inequality is a global one, and it is intimately connected to other urgent issues of our time, including not only the rapid change brought on by technological advancement but also the crisis brought on by climate change, urbanization, and migration. In many locations, the rising tide of inequality may further swell as a result of the force of these megatrends. However, the future course of these complicated problems is not irreversible[20]. Either we can work together to harness the effects of technological change, migration, urbanization, and even the climate crisis to create a world that is more equitable and sustainable, or we can choose to let them further divide us. Governments are key actors in the process of creating societies that are more equitable, protecting the most vulnerable from the negative effects of these trends, and ensuring that the benefits of these trends, as well as the costs of adapting to them, are shared widely and equitably. However, because our increasingly interconnected world means that the decisions made in other countries can influence the process of formulating national policy, international cooperation is more essential than it has ever been.

Rising inequality is not inevitable[20]; national policies and institutions can help ensure that the benefits of these global trends are broadly shared and that the negative effects of these trends do not fall disproportionately on those who lack the resources to deal with them and recover from them.

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The Key Drivers of Income Inequality

Demographic Variables

Population density and age dependency, also known as population structure, are two of the most important demographic factors that are thought to have an effect on income inequality. The population density of a country is an indicator of the relative scarcity of its natural resources and the relative strain that is being placed on it carrying capacity[21]. Therefore, it has been hypothesized that population density acts as a rough indicator of a demographic burden that contributes to greater levels of absolute and relative poverty among the general populace. A higher youth dependency, which is defined as the ratio of the number of people aged 0–15 to the number of people aged 16–64, is hypothesized to lead to greater income inequality. This is primarily the case because a higher youth dependency suggests a higher average number of children per household as well as a lower household per capita income. In a similar vein, old-age dependency, which is defined as the ratio of people aged 65 or over to the number of people aged 16–64, is expected to be associated with relatively lower income inequality because this age group has a flatter income profile than the other age groups. However, people in these two age groups are dependent on the working population, which is why a country's dependency burden is largely determined by the size of its working population. This is especially true in developing countries. Because a greater dependency burden would mean lower incomes per capita or greater income inequality, the expected sign for each variable is positive if all other factors remain constant.

Human Capital

It is a commonly held belief that an increased level of education or skill premium, which can be thought of as a representation of the spread of education or the "deepening" of skills, should lead to an increase in the income of households and individuals, which in turn should

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lead to a reduction in income inequality. The extent to which education can exert a leveling effect on the distribution of income is also dependent on the political economy of education, which determines how education policy and educational institutions facilitate educational expansion and react to it[21]. The extent to which education can level out the distribution of income depends on the political economy of education.

Globalization

It is hypothesized that different indicators of globalization will have varying effects on the distribution of income. As an illustration, the Stolper–Samuelson theorem is the primary analytical link that can be drawn between the liberalization of trade and increased income inequality. It suggests that increased trade openness in a developing nation that has an abundance of low-skilled labor would result in an increase in the wages of low-skilled workers and a reduction in the compensation of high-skilled workers, which would lead to a reduction in income inequality because of the decrease in income inequality. As a result, high-income countries trade goods that require a lot of capital and expertise while importing low-skilled workers and goods that require a lot of labor from low-income countries. The latter decreases relative prices and wages in import-competing sectors, which in turn increases the inequality between the incomes of labor and capital, as well as between workers with low and high levels of skill. On the other hand, it is anticipated that the import-induced relative reduction in prices and wages in sectors of low-income countries that are capital- and skill-intensive will result in a reduction in income inequality[22].

2.2 Theoretical Review

The Piketty Theory, the Lorenz Curve, and the Kuznets Curve Hypothesis are some of the major theories that explain the dynamics and complexities of income inequality. Other theories that show the link between globalization and the environment include the Pollution

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Haven theory and the Environmental Kuznets Curve theory, respectively. Each of these theories, in their own unique way, tries to uncover the underlying mechanisms of globalization, environmental degradation, and income disparity, as well as the relationship between these three factors.

2.2.1 Theoretical link between Globalization and Environment

2.2.1.1 Pollution Haven Hypothesis

The PHH was initially proposed by Copeland and Taylor in the context of North-South trade in accordance with the North American Free Trade Agreement (NAFTA). It was the first paper to make the connection between the stringency of environmental regulations and the trade patterns of a country with the level of pollution in that nation.

In addition, they argued that because of trade liberalization, businesses that manufacture goods through processes that generate the most pollution would move from developed nations that have stringent environmental regulations to developing nations that have relatively weak environmental regulations. This migration would take place from rich nations to developing nations. Therefore, because of open and liberalized trade, developing countries would become a haven for polluting industries from more developed countries. The PHH predicted an environmental disaster in these developing countries that had comparatively weak environmental regulations[23]. According to the PHH, the movement of polluting industries from developed countries to developing countries takes place as a result of international trade and foreign direct investment (FDI) from other countries. This phenomenon is being driven by the comparative cost advantage enjoyed by developing countries due to lower pollution controls. Developing countries have lower pollution control costs. The developing nations have a propensity for specialization and the export of dirty goods, whereas the developed nations have a propensity for specialization and the export of

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clean goods. As a direct consequence of this, developing countries are increasingly becoming a haven for polluting industries that are in more developed nations. Critics of trade liberalization also argued that the weak environmental standards of poor and developing countries were to blame for the concentration of pollution-intensive industries in those countries. They claim that the consumers of the developed world enjoy pollution-intensive goods at lower prices due to the underpricing of environmental resources in developing countries. This phenomenon of the concentration of pollution-intensive industries in poor and developing countries is known as PHH.

2.2.1.2 The Environmental Kuznets Curve

The theory was proposed by Grossman, G., and Krueger[24]. The fundamental concept of the EKC stipulates that nations in the early stages of development disrupt the quality of the environment through the economic activities they engage in with the goal of achieving growth[25]. The economies of these pre-industrial countries, which are based on the primary sector, function at the initial level of the EKC, which is upward sloping. However, countries (middle-income countries) enter the next level of the EKC when continued economic growth helps to boost the industrial economy and growth-led increases in income get closer to achieving a threshold level of per capita income.

Additional increases in the post-industrial economy's per capita income, which is primarily based on the tertiary sector, bring countries to the desired level of the EKC (a downward sloping level), at which point the ecological condition begins to improve[26,27].

Since Grossman and Krueger first presented their EKC in 1991, it has become widely accepted as the method of choice among economists for modelling ambient pollution concentrations and total emissions. Despite this, the EKC has been criticized on statistical and policy grounds almost from the very beginning, and the debate is still ongoing. Although

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there is clear evidence that concentrations and emissions of certain local pollutants, such as Sulphur dioxide, have decreased in developed countries in recent decades, the evidence for other pollutants, such as carbon dioxide, is significantly weaker. Initially, many people interpreted the EKC to imply that environmental problems might be the result of insufficient economic development, which is the opposite of what was typically believed, which was that the reverse was the cause. Others were concerned about this because a simplistic policy prescription that was based on this idea could potentially make environmental problems worse, such as climate change, even though it might solve some environmental problems, such as deforestation or local air pollution. In addition, a significant portion of the econometric research that was conducted in support of the EKC was discovered to have statistical weaknesses. The EKC paints a simplistic picture of the relationship between environmental impacts and development. However, more recent research that incorporates the EKC with alternative methods reaches the conclusion that the nature of this relationship is more nuanced. According to the findings of this research, an expansion in the size of the economy almost always results in an increase in the environmental impacts that are caused by that economy. However, the impact of growth may decrease as countries get richer, and richer countries are likely to make faster progress in reducing environmental impacts because of their increased ability to do so. Finally, there is frequently a convergence among nations, which means that nations with relatively high levels of impacts can lower them more quickly or increase them more slowly, provided that all other factors remain unchanged.

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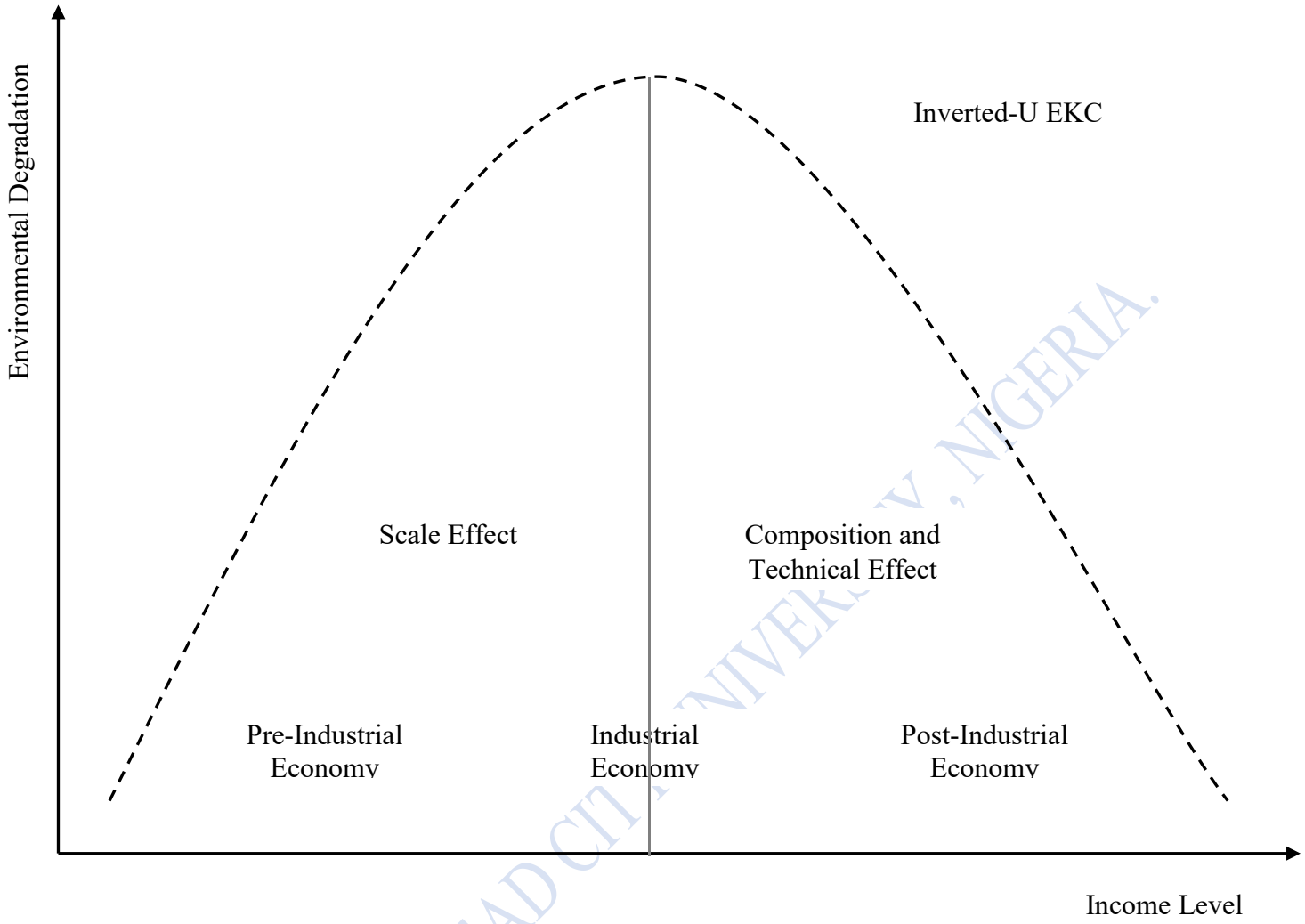

Figure 2.1: Inverted-U EKC
Source: Halkos (2003)

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The EKC hypothesis holds that there is an inverse-U-shaped relationship between economic activity, as measured by "Income per Capita," and environmental quality, as measured by environmental indicators such as per capita CO_2 emission. This means that during the first stage of economic growth, environmental degradation would increase with an increase in per capita income but would begin to decrease once the income turning point was reached[28].

2.2.2 Theories of Income Inequality

2.2.2.1 Piketty Theory

The main argument of Piketty's thesis is that the growth of wealth vastly exceeds the expansion of the economy as a whole, whereas wage growth almost never surpasses the expansion of the economy as a whole. This disparity causes a concentration of wealth (assets) in the hands of a few people, which gives those people more opportunities to save and invest, giving them a larger share of the total value added to the economy and, as a result, increasing the income gap between different groups to a greater extent. Piketty says that owners of capital around the world have made between 4% and 5% per year before taxes, even though the economy has grown by about 1.5% per year. Piketty forecasts that the ratio of capital to income will continue to rise, leading to an increase in the gap between the rich and poor. Capitalism automatically creates arbitrary and unstable disparities that radically undermine the meritocratic values on which democratic societies are based when the rate of return on capital exceeds the rate of growth of output and income. This occurs when the rate of return on capital is greater than the rate of growth of output and income. Inheritance will have a self-perpetuating influence as capital stock and the returns on it mount up, which will undercut any idea that compensation is based on merit[29]. Taxation is the answer that Piketty proposes to the problem of growing inequality, whether it be in terms of wealth or income. These taxes include high progressive income taxes and inheritance taxes, but a global annual wealth tax is particularly important. Piketty is pessimistic about the possibility of a

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worldwide wealth tax being implemented, but he argues that there is a possibility that it may be implemented gradually on a regional basis. The major objective of the global wealth tax is not to provide revenue for the welfare state but rather to control the free market economy. The first objective is to narrow the wealth gap, and the second is to ensure that the financial and banking sector is subject to stringent supervision to forestall future financial meltdowns. Piketty is of the opinion that for the authorities to exert sufficient control over the monetary system, they require far more detailed information on the holdings and movements of wealth. The production of such data would be a necessary by-product of a worldwide wealth tax scheme. Piketty does not discuss the efficacy or efficiency of public sector spending - whether or not those overpaid capitalists are being adequately taken advantage of by the taxman[30].

Piketty's Analysis

Piketty grounded his research in what he refers to as the "two fundamental laws of capitalism" to make his findings accessible to qualified economists. The first law is that the share of national income flowing to capital (a) is equal to the rate of return on capital (r) multiplied by the ratio of the stock of capital to income (β). Hence, $a = r \times \beta$. The second law holds that, in the long run, the ratio of capital stock to national income (β) is equal to the percentage of income that is saved (s) divided by the rate of growth in national income (g). Hence $\beta = s/g$. The rate of saving is net of capital depreciation, so if a population saves a lot, the capital stock ratio (β) will tend to grow, which, in turn, will produce growing inequality[30].

The debate over unequal wealth distribution has recently resurfaced because of Thomas Piketty's work, which raises concerns about the equity and long-term viability of the dominant capitalism system in the Western world. Piketty's overall conclusion from studying his historical sources is that a market economy based on private property, if left to its own devices, has powerful forces of convergence, especially when it comes to the spread of

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knowledge and skills. It also has powerful forces of divergence, which could be a threat to democratic societies and the values of social justice they are based on. The fact that the private rate of return on capital, denoted by the letter r, can be significantly higher for extended periods of time than the rate of growth of income and output, denoted by the letter g, is the primary factor that contributes to economic instability. The inequality, r > g, implies that previous wealth grows faster than output and wages. According to Piketty, this inequality is an expression of a basic logical contradiction. The entrepreneur has a natural propensity to inevitably become a rentier, becoming more and more dominant over those who have nothing but their labor. Once established, capital reproduces itself faster than output grows.

Piketty contends that the long-term dynamics of wealth distribution have the potential to be terrifying. This is especially true when considering the fact that the return on capital is directly proportional to the size of the initial stake and that the disparity in wealth distribution is occurring on a global scale. Piketty does not offer a straightforward resolution to this issue. He is of the opinion that economic expansion can be stimulated by making investments in areas such as education, knowledge, and technologies that do not pollute the environment. None of these, however, can raise the annual growth rate to between 4 and 5 percent. According to historical evidence, only countries that are rapidly catching up with economies that are already advanced (such as Europe after World War II and China today) can grow at such rates, according to historical evidence. He is of the opinion that the growth rate for most nations will not exceed 1-1.5 percent, regardless of the economic policies that are implemented. A rise in the growth rate, denoted by g, would result in a rise in the return on capital, denoted by r, but would not necessarily bring about a narrowing of the gap, denoted by r-g. It took two world wars to even out the differences in capital from the past. The only solution is to increase taxes on capital to such an extent that private returns on capital fall below the rate of economic growth. But Piketty agrees that if this was done in a heavy-

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handed way and without much thought, it could kill the engine of accumulation and slow growth even more. There would be no more risk-taking business owners! Piketty has made an unexpected concession here, which is very interesting. Piketty contends that a progressive annual tax on capital is the "right solution" for preventing an endless in egalitarian spiral while maintaining competition and incentives as new sources of accumulation.

2.2.2.2 Kuznets' Curve Hypothesis

Simon Kuznets first published his research results on the relationship between income inequality and economic growth [31]. According to the hypothesis, a country will have relatively low income (wage) inequality at the beginning of its development, but this will change as the country continues to develop. The difference between the rich and poor will get worse because the agricultural sector is much less productive than the emerging and growing industrial sector. Kuznets argued that after the initial rise in wage inequality, a decline in wage dispersion should be expected due to, first, a shift in labor from the agricultural sector to industry, and second, progress in agricultural modernization and productivity[32].

The resulting relationship, known as the Kuznets curve, has the shape of an inverted U.

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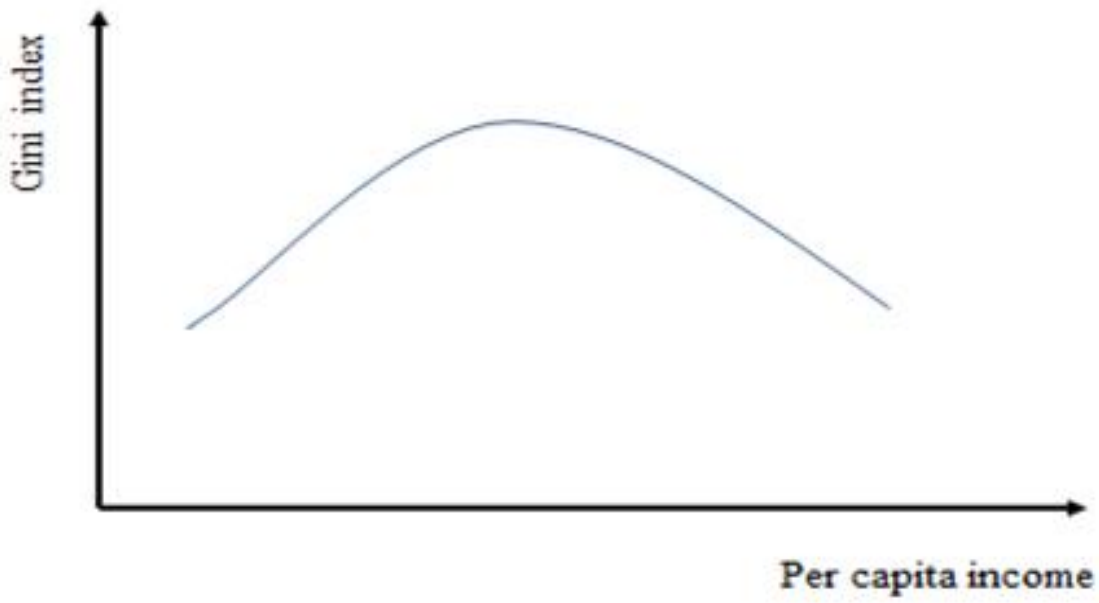

Figure 2.2: Kuznets Curve

Source: Google

The idea that underpins this hypothesis is a simple one. A country in a low state of development tends to be characterized by relative equality in the income distribution. Everyone is living in the same low condition.

As the economy begins to grow, and per capita incomes begin to increase, some groups will gain more than others from the growth. The entrepreneurs will experience rapidly growing income levels, but others will be excluded. Inequality grows, and the Gini index rises.

This process continues until the economy reaches a stage at which the government begins to step in to reduce poverty and spread the benefits from economic growth. In this stage, the Gini index falls again as inequality lessens. This then provides the inverted U-shape above.

According to Kuznets, excluding government intervention, there are two forces that explain income inequality before taxes: the concentration of savings in the upper income groups and the industrial structure of the income distribution. The former yields inequality in savings which, all other conditions being equal, has a cumulative effect of increasing the proportion of income yielding assets in the hands of the upper income groups leading to larger income

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shares of these groups and their descendants[31]. The other force is the result of the process of industrialization and urbanization, this is, economic growth accompanied by the shift away from agricultural activities. On one hand, the process increases the urban share in total population, which is assumed more unequal than rural population. On the other hand, since average per capita income of rural population is usually found lower than that of the urban, Kuznets argues, that this gap in relative mean incomes tends to widen because of a more rapid growth of the per capita productivity in economic urban activities than in agriculture.

However, despite the cumulative effect of the concentration of savings, eventually these tendencies reverse over time, according to Kuznets as a result of both government redistributive intervention through legislative interference and political decisions and a group of "less obvious" factors which characterize a dynamic growing economy.

2.2.2.3 Lorenz Curve Hypothesis

An American economist by the name of Max O. Lorenz developed a method for determining the degree to which wealth is concentrated in 1905 and named it the Lorenz curve. It depicts a graphical relationship between the cumulative normalized rank of the population from the poorest to the richest and the cumulative normalized wealth held by these population groups from the poorest to the richest[33]. Over the course of more than a century, the Lorenz curve has been put to extensive use both for illustrating distributions of wealth and income and for analyzing the degree to which these distributions are unequal. Income inequality would be relatively simple to estimate if individual records on personal or household income data were available[34]. Unfortunately, the lack of individual data has made it hard to do a lot of research on economic inequality in the past.

The relationship between the cumulative proportion of people with incomes at least equal to some specific value and the cumulative proportion of income received by these people is

expressed by the Lorenz curve. The Lorenz curve is represented by a function L (P), and it corresponds to a fraction of the population's total income that is received by the p-th lowest fraction of the population when the population is ordered by increasing income.

The curve slope is always positive and convex, so L (0) = 0 and L (1) = 1.

The line L (p) = p is the line of perfect equity, corresponding to the OB line in the graph below. It is a scenario in which everyone receives the same amount of income for their efforts. The line that corresponds to the lines AO and AB is the line of extreme inequity. It is a situation in which everybody receives zero income except the richest person, who accumulates the total income.

The Lorenz curve is always drawn in such a way that it is situated between the line of perfect equity and the line of extreme inequity. The income distribution is said to be more egalitarian when it is closer to the line indicating perfect equity.

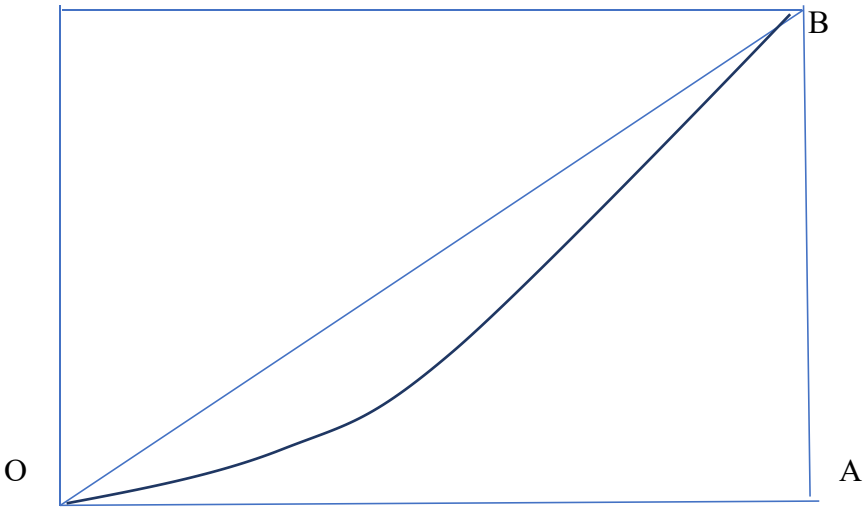

Figure 2.3: Lorenz Curve
Source: Author 2022

2.3 Review of Empirical Studies

The findings of previous research have not come to a consensus on how to combat income inequality while also considering the effects of globalization and maintaining environmental sustainability. This demonstrates the need for additional research to be conducted in this area. In addition, the economies of the world are distinct and varied, each exhibiting its own set of distinctive macroeconomic characteristics. Each must find and adopt their specific measures of dealing with income inequality. The findings of these past studies are discussed in this section.

2.3.1 Globalization and Environmental Sustainability

The changing climate is one of the most significant challenges that the world is facing right now. This is because burning fossil fuels raises the amount of CO_2 and other gases that contribute to global warming in the atmospheres of many countries around the world, including ECOWAS, which is also affected by this.

Using quarterly frequency time series data from 1971 to 2018, a scholar investigated the effects of globalization, real income, urbanization, and energy consumption on environmental degradation[35]. The scholar also proposed a way forward to achieving environmental sustainability targets in Nigeria. To achieve their study objectives, they made use of the quantile-quantile (Q-Q) approach. This methodology brings together nonparametric estimation and quantile regression into a single approach. The empirical findings indicate that globalization, real income, urbanization, and energy consumption all have a positive impact on the deterioration of the environment across all quantiles. As a result, they were of the opinion that in order for the nation to achieve any meaningful environmental sustainability targets, it was necessary for it to do the following: transition away from economic activities that are dependent and driven by non-renewable energy sources; enact environmental laws and regulations that prevent indigenous and multinational firms from using non-renewable

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energy sources in production activities; discourage rural-urban migration by enacting policies that would improve life in the rural areas, such as diverting investment of indigenous and multinational companies to be situated in the rural areas; and lastly, learn from jurisdictional experiences that have successfully replaced non-renewable energy sources with renewable ones for overall economic growth and environmental sustainability targets for both the immediate and future generations[36].

Similar research attempted to provide a comprehensive review of globalization, the green economy, and the climate challenges to draw some implications. There is contention between various green economic discourses, and there is a wide range of definitions, all of which have issues. Common examples of green economy operationalization include acknowledging the negative effects that natural resource depletion has on the environment as well as the economic benefits that come from effective environmental management. This research also investigated how climate change will affect the green economy and infrastructure development. In addition, the role that economic structure plays in mitigating environmental issues, increasing production efficiency, and enhancing green economies and environmentally friendly technologies is also investigated further in this study. They concluded that pursuing a green economy helps reduce poverty in the four ways that were outlined in this study[37].

By controlling the critical influence of information and communication technology (ICT) and economic growth in a panel of One Belt One Road (OBOR) countries from 1991 to 2019, another researcher investigated the connection between technological innovation, globalization, and CO_2 emissions. This study made use of advanced and robust econometric strategies (second generation). In addition to their direct effect on CO_2 emissions in OBOR countries, this study made use of an interaction variable (TI*GLOB) to investigate the interaction role that technological innovation plays in the linkage between globalization and

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CO_2 emissions. This was done in addition to examining the direct effect that these factors have on CO_2 emissions in OBOR countries. The findings show that there is a negative link between technological innovation and CO_2 emissions, and that this link is statistically significant in each region (e.g., OBOR, South Asia, East and Southeast Asia, MENA, Europe, and Central Asia). In addition, the findings of the study show that there is a significant positive relationship between globalization and CO_2 emissions in the OBOR and South Asia region. Despite this, it has a significant and detrimental impact on environmental pollution in East and Southeast Asia, the Middle East, and North Africa (MENA), Europe, and Central Asia. The findings of TI*GLOB indicate that the moderating effects of technological innovation with globalization are significantly negatively associated with CO_2 emissions for the OBOR sample, East and Southeast Asia, and Central Asia. This is the conclusion drawn from analyzing the data collected from all three regions. On the other hand, the interaction effect produces a significant positive in both the MENA region and Europe. However, these results are statistically negative for the East, Southeast Asia, and MENA regions. The coefficient of ICT is positive and statistically significant for OBOR, Europe, and Central Asia. However, these results are statistically negative for the East, Southeast Asia, and MENA regions. In addition, the findings were reliable, as indicated by the numerous robustness checks that were carried out to determine the degree to which their primary findings could be relied on[38].

Similarly, another research carried out utilized panel data from 15 developing economies from 1970 to 2012 in order to investigate the impact that economic globalization has on CO_2 emissions. The findings indicated that globalization of the economy resulted in a reduction of CO_2 emissions. The consistency of the link was observed across a wide range of econometric parameters[39].

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An examination of the role of financial sectors, globalization, and renewable and non-renewable energy consumption for a sustainable environment in the Central and Eastern European (CEE) nations was carried out by some researchers. They did this by using annual data from 16 Central and Eastern European economies from 1980 to 2016. The empirical findings of a dynamic, seemingly unrelated regression confirm that globalization improves the environmental performance of the economies of Central and Eastern Europe (CEE)[40].

Throughout the years between 1975 and 2015, a few researchers conducted research with the goal of determining how much of an impact globalization had on Pakistan's ability to maintain a sustainable environment. Their long-run estimates using econometrics techniques such as Johansen co-integration, ARDL bound testing approach and variance decomposition show that globalization has a significant impact on the amount of carbon emissions in the long run. The results showed that a 1% increase in economic globalization, political globalization, and social globalization will increase carbon dioxide emissions by 0.38, 0.19, and 0.11%, respectively[41].

A research project was carried out by a group of academics with the goals of investigating the effects of economic globalization (EG) of agriculture on environmental sustainability and putting the EKC hypothesis to the test on the agricultural sectors of six countries located in Central Asia. Specifically, some primary hypotheses were proposed by utilizing secondary data from the countries of Kazakhstan, Kyrgyzstan, Mongolia, Tajikistan, Turkmenistan, and Uzbekistan from the years 1994 to 2019. The study used five explanatory variables: the value of agricultural exports (EXP), the value-added from agriculture, forestry, and fishing (AVA), the exchange rate (EXR), total natural resource rents (RENT), and external debt stocks (DEBT). The CO_2 emissions from on-farm energy use (EMS), temperature changes (TEMP), and forest fires were the dependent variables in this study (FIRE). The analysis of these datasets was carried out using panel data regression, AVA, and RENT both increase EMS,

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whereas EXC increases TEMP but decreases EMS, and DEBT raises TEMP but can decrease FIRE. As a result, they proposed some recommendations to help improve the situation, such as establishing a clear roadmap, strengthening partnerships, and gaining support at a regional and international level[42].

A researcher investigated the effects of globalization on environmental pollution using data from 38 countries in Sub-Saharan Africa for the period from 1980 to 2017. The researcher differentiated between the de jure and de facto aspects of the situation while conducting the study. The variables that are included in the de facto globalization measures are those that represent flows and activities, whereas the variables that are included in the de jure globalization measures are those that represent economic policies that, in theory, orient flows and activities. They utilized the second-generation panel data tests developed by Pesaran to investigate the cross-sectional dependence of the variables in addition to the unit root. To consider spatial dependence, heteroscedasticity, and the autocorrelation of errors, the panel specification developed by Hoechle was used in conjunction with his estimation method. They discovered that globalization, along with its de jure and de facto aspects, contributes positively to environmental pollution in SSA by increasing carbon dioxide (CO_2) emissions. This is one of the ways that globalization contributes to environmental pollution. To achieve sustainable development, decision-makers need to take action to reduce long-term CO_2 emissions[43].

Exploring the relationship between economic globalization and environmental quality in sub-Saharan Africa while considering the role that institutions play in determining this relationship is also a focus of this research (SSA). The method of generalized methods of moments was utilized in the analysis of the data spanning the years 2002–2017 for the purpose of the study. According to the findings, the quality of regulations has a positive impact on environmental degradation in SSA, whereas globalization and the lack of control

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over corruption have a negative impact on environmental degradation. In addition, the findings demonstrated that a region's economic growth and the effectiveness of its government have a negative impact on the environment, whereas the region's institutional index has a positive impact on the environment in that region. It was also discovered that the interaction between economic globalization and institutions has significant and negative effects on environmental pollution, which contributes to the quality of the environment. As a consequence of this, the study suggests that governments should work toward the establishment of stringent trade regulations that take environmental considerations into account[44].

2.3.2 Globalization and Income Inequality

For the same 15 member states of the Economic Community of West African States (ECOWAS), other researchers looked at the connection between regional integration and inequality between 2004 and 2013. They employed a dynamic panel estimation technique that considers the fact that the distributional pattern of income inequality is path dependent. In addition, they addressed potential endogeneity problems using a technique called Least Squares Dummy Variable Corrected (LSDVC). Their discoveries imply the following: Economic integration, as indicated by the intra-regional export ratio or the share of total intra-regional goods trade (as a percentage of total ECOWAS trade), significantly widens the income gap; this effect is more pronounced than that of individual intra-regional export ratios (as a percentage of a country's total exports). The path-dependent and viscous characteristics of inequality are accounted for by the Gini coefficient's historical value. Employment naturally has the opposite impact on income disparity, whereas foreign direct investment (FDI) considerably reduces it[45].

In a similar vein, a number of researchers have investigated the relationship between openness to trade and income inequality within nations. During the time period of 1970–2014,

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the sample consists of 139 different countries. They determined the causal effect of trade openness on inequality by employing an approach known as the instrumental variable (IV) approach. They did this by employing a new identification strategy and considering the fact that countries differ in their levels of heterogeneity. As a result, they investigated how the openness of trade affects income inequality. The IV made its predictions regarding openness based on a gravity equation that incorporated a time-varying interaction between geography and exogenous, large-scale natural disasters. This equation was proposed by[46]. The findings show that trade openness within emerging and developing world tends to decrease income inequality[47].

Similarly, to present a quantitative summary and analysis of existing estimates regarding the relationship between globalization and inequality, a researcher utilized a new data set that was comprised of 1254 observations taken from 123 papers that had been subjected to peer review. They were able to obtain a few primary findings by employing methods such as meta-analysis and meta-regression. First, when the total population of estimates is taken into consideration, globalization has a positive impact on income inequality that ranges from slight to moderate. The fact that the effect, on average, is significantly different from zero lends credence to the notion that globalization exacerbates existing income disparities. Second, although the impact of globalization on inequality has been shown to be relatively minor, the impact of globalization on financial markets has been shown to be much larger and significantly more potent. Third, the accumulated evidence refutes theoretical accounts, such as the one that states economic globalization lowers within-country income inequality in developing countries. This is because the meta-analysis establishes that globalization has an impact that increases inequality on average in both developed and developing countries. Fourth, the effects of globalization on income inequality are mitigated by advancements in education and technology. Fifthly, they looked into a variety of other variables that might

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have contributed to the observed discrepancies in the reported results. These variables included variations in the econometric specifications, the income inequality measures, the data set that was utilized, and the publication characteristics[48].

When looking at how different countries in sub-Saharan Africa (SSA) are affected by the impact of trade on income inequality. Some researchers used fractional regression models for panel data as their method of estimation. They also used a balanced panel consisting of 11 countries that covered the years 1980–2008. The empirical findings showed a negative association between income inequality and trade, which is a sign that trade helps reduce income inequality in SSA. This finding supports the hypothesis that trade has this effect. In the study, we also discovered evidence that a lack of democracy (or the presence of an autocracy) contributes to greater income inequality, whereas a higher level of educational attainment was found to reduce income inequality. The fact that there is evidence to suggest that increased trade lowers income inequality may be an indication that their findings support the Stolper-Samuelson (SS) theorem in the Heckscher-Ohlin (HO) model that was used in the study[49].

2.3.3 Environment Sustainability and Income Inequality

The most important issue of our time, with complex and changing dynamics, is climate change. There has been a lot of focus on how climate change affects financial stability and economic productivity, but there has been far less attention paid to how it affects income disparity.

Using data from a sizable panel of 138 nations between 1955 and 2019, some researchers looked at the connection between climate change and wealth inequality and discovered new evidence for the association. To analyze the evolution of income inequality in response to climate change shocks, they used a new dataset of climate change vulnerability (and

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resilience) created by the Notre Dame Global Adaptation Institute (ND-GAIN). They also used alternative estimation methodologies, such as a standard panel regression analysis and a panel vector autoregression (VAR) model. They discovered that rising economic inequality is positively correlated with increased climate change vulnerability. Interesting contrasts in the effects of climate change on income inequality are seen when the sample is divided into groups of countries. While climate change vulnerability has no statistically significant impact on income distribution in advanced economies, the coefficient on climate change vulnerability is seven times higher and statistically highly significant in the case of developing nations, largely because of weaker capacity for climate change adaptation and mitigation[50].

To determine whether changes in income inequality had an impact on carbon dioxide (CO_2) emissions in OECD nations, more study was conducted. By considering how income inequality affects carbon emissions, they looked at the connection between economic growth and CO_2 emissions. The fraction of pretax income received by the richest 10% of the population in OECD countries served as a new data source for the study of top income inequality. Since the two metrics capture various aspects of the income distribution, they also used Gini coefficients. They discovered that an increase in top income inequality is positively associated with CO_2 emissions using recently developed panel data estimation techniques. A nonlinear relationship between economic growth and CO_2 emissions was also found, which is in line with the environmental Kuznets curve. They discovered that, in line with the marginal propensity to emit theory, a rise in the Gini index of inequality is related with a fall in carbon emissions. Their findings held up well against several alternate standards. From a policy viewpoint, it is significant to note that their findings indicated that measures to lower top income inequality can both lower carbon emissions and enhance environmental quality[51].

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Another study looked at the key factors influencing the short- and long-term patterns of CO_2 emissions as a result of changes in growth and income inequality for 11 Mediterranean economies from 1990 to 2012. To (i) test for non-linearity between income inequality and CO_2 emissions, (ii) determine whether there is a differentiated effect of income inequality on CO_2 emissions depending on the level of GDP, and (iii) test for other sources of non-linearity between income inequality and CO_2 emissions, it proposed an autoregressive dynamic distributive lag dynamic panel specification. According to the findings, there is a direct and significant link between carbon emissions and income disparity, which suggests that higher inequality causes environmental deterioration. However, the findings indicate a positive and significant correlation between CO_2 emissions and income disparity in the short term[52].

Some academics conducted additional research to examine the impact of financial instability and income inequality on CO_2 emissions in the context of fossil fuel energy, economic growth, industrialization, and trade openness. They used the stochastic effects by regression on population, affluence, and technology (STIRPAT) model to analyze panel data from 47 developing nations for the years 1980–2016. According to the empirical findings of all models, income disparity and industrialization greatly slow down environmental deterioration, whereas fossil fuels, trade opening, and economic development worsen it. Without the interaction term, financial instability, however, does not significantly link to environmental quality, however with the interaction term, it significantly negatively impacts CO_2 emissions. Additionally, the outcome of the interaction variable shows that, ceteris paribus, an increase in inequality combined with an increase in financial instability is anticipated to result in an increase in pollution. Furthermore, there is a bidirectional causal relationship between the interaction variable with CO_2 emissions and the following variables: income inequality, financial instability, fossil fuels, trade openness, industrialization, and economic growth[53].

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Another researcher most likely validated the link between CO_2 emissions and income inequality for the years 1980–2008. The study's findings for low- and middle-income countries showed a bad correlation between income inequality and CO_2 emissions. On the other hand, the inverse association is shown to be true in countries with high incomes and upper-middle incomes[54].

In terms of growth, some researchers used a cumulative growth model to experimentally examine the impact of income disparity on growth for 43 nations between 1991 and 2014. The findings indicate a positive association between the income disparities of lagging countries and the corresponding growth gaps with the frontier country, according to estimation results using a simplified equation. This demonstrates how growth is severely impacted by the rise in income disparity. Second, a cumulative growth model utilizing 3SLS estimate demonstrates that only investment is negatively impacted by income disparity. However, neither the increase of human capital nor technical innovation were found to be correlated with income inequality. They concluded that because investment positively affects productivity, income inequality negatively affects investment, which in turn negatively affects productivity, which therefore negatively affects growth. Third, they discovered that income inequality in developing nations is inversely connected with growth, particularly for investment, against Kaldor and Barro's assumption. Both developed and developing nations were shown to experience a similar impact of income inequality on investment. Additionally, they discovered regional variations in the ways that income inequality affects long-term economic growth[55].

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2.4 Conceptual Framework

Figure 2.4 depicts the conceptual interactions between globalization, environmental sustainability, and income inequality. The role of globalization in environmental sustainability and income inequality varies by country group. While globalization has some benefits, it also has some drawbacks for the environment. Globalization has aided environmental pollution by increasing the consumption of non-renewable fossil fuels and natural resources, both of which generate waste. This is due to the fact that globalization places a strong emphasis on commerce, including import and export. If demand exceeds supply, exporting may result in the crude exploration of natural resources. Globalization has an impact on the ecological cycle because increased trade and financial openness has resulted in increased consumption of goods and services. High consumption raises the production of goods, putting additional strain on the environment.

As to the globalization-inequality nexus, globalization can increase wage inequality through resource (primary goods) transfer from poor to rich countries, thereby leaving the richer/affluent members of society that control the resource transfer to cope better than less privilege members.

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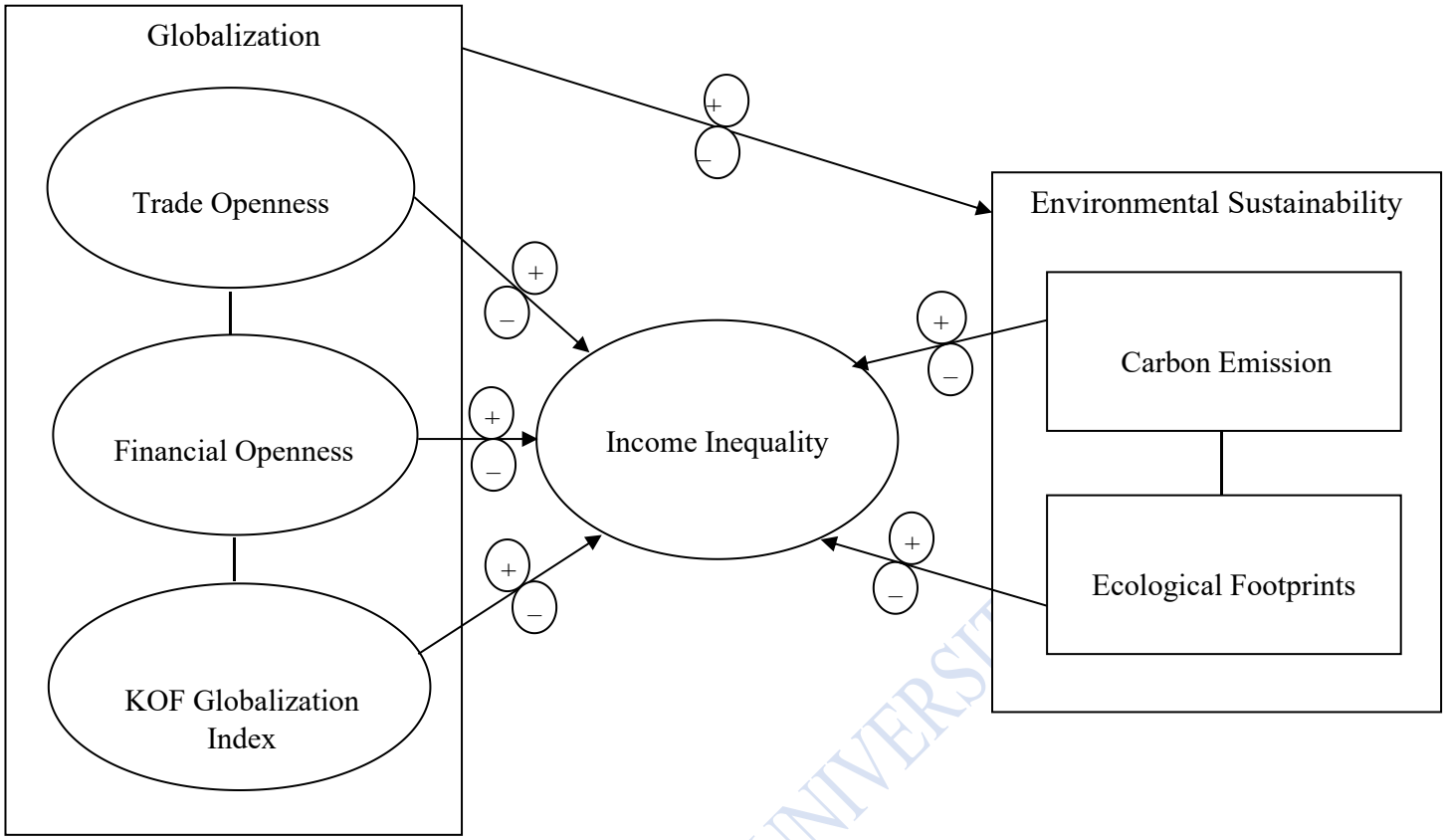

Figure 2.4: Conceptual linkages between globalization, environmental sustainability and income inequality
Note: (+ sign in circle) denotes increase and (– sign in circle) implies decrease
Source: Author's conceptualization.

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The government, whose interest is to ensure the equal distribution of income among its citizens, frequently implements policies to ensure positive externalities of globalization and a clean and sustainable environment through green production methods. However, the type of environmental policies and institutional frameworks in place frequently determine how income distributions can be ensured in the direction of human welfare development. According to the diagram, two environmental sustainability dimensions, carbon emissions and ecological footprints, appear to play critical roles in determining how income can be distributed. Consider carbon emissions: if carbon dioxide emissions can be properly controlled, income equality tends to improve due to high income growth from human health development; otherwise, income equality tends to suffer. In a situation where pollution is kept to a bare minimum, increased overseas trade and foreign investment will not only have a positive impact on income but will also ensure equitable distribution of income. Proceeds from international trade, for example, will contribute to environmental sustainability, reduce carbon pollution, and reduce income inequality. Similar stories appear to be true for other aspects of environmental sustainability.

2.5 Theoretical Framework

The theoretical foundation of the Kuznets inequality hypothesis is crucial to this investigation. According to Kuznets, inequality will rise during the early stages of economic development. Inequality may decline if governments implement redistributive policies that combine progressive taxes with welfare spending at a later stage in the economic cycle. The paragraph that follows discusses the main points of Kuznets' argument regarding the link between inequality and progress and is taken from his 1955 paper:

> "The transition away from agriculture, which is typically referred to as industrialization and urbanization, is an invariable accompaniment of growth in developed countries. The transition away from agriculture, which is typically referred to as industrialization and urbanization, is an invariable accompaniment

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> of growth in developed countries. In the most basic form, the whole population's income distribution can be seen as a synthesis of the total income distributions of the rural and urban populations. The two component income distributions' structure, which we do know a little about, shows that a) the average per capita income of the rural population is typically lower than that of the urban population and b) inequality in the percentage shares within the distribution for the rural population is somewhat narrower than that in the urban population. What conclusions do we draw using this straightforward model? First, given all other factors being equal, the proportion of urban dwellers will increase, favoring the more unequal of the two component distributions. Second, the relative gap in per capita income between the rural and urban populations does not always narrow because of economic expansion; in fact, some evidence suggests that it is, at best, stable and tends to widen as per capita productivity in urban rather than agricultural pursuits rise more quickly. Inequality in the distribution of all income should rise if this is the case."[56]

Two sub-processes make up the Kuznets process, which is the growing of inequality with structural change (the movement of labor away from agriculture). Within-sector inequality is the movement of the population from a sector with low within-sector inequality to a sector with higher within-sector inequality, and between-sector inequality is the movement of the population from a sector characterized by lower mean income to a sector characterized by higher mean income. Inequality will undoubtedly rise as a result of structural change if both sub-processes move in the same direction, that is, if employees shift from a sector with a low mean and low variance in earnings to one with a higher mean and high variance. However, it is less certain that inequality will inevitably rise if workers transfer from a sector with a low mean income but large variance of income to a sector with a higher mean income but reduced variance of income[56].

Following the above discussion on the Kuznets Curve hypothesis, the general form of the relationship between income growth and income inequality is stated as:

$$ineq = f(inc, inc^2) \qquad (2.1)$$

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The above model states income inequality (*ineq*) as a function of income per capita and the square of income per capita. In mathematical form, it becomes:

$$ineq = \theta_0 + \theta_1 inc + \theta_2 inc^2 \quad (2.2)$$

Where: *ineq* represents income inequality; *inc* is income per capita measured by gross domestic product per capita; inc^2 denotes the square of income per capita; θ_0 is constant; θ_1 is the parameter of *inc*; θ_2 is the coefficient of inc^2. From the equation, there is no relationship if $\sigma_1 = \sigma_2 = 0$. Meanwhile, if $\sigma_1 < 0, \sigma_2 = 0$ and/or $\sigma_1 > 0, \sigma_2 = 0$, the relationship is said to be monotonically reducing and/or increasing respectively. Also, if $\sigma_1 < 0, \sigma_2 > 0$, a U-shape relationship is represented. However, if $\sigma_1 > 0, \sigma_2 < 0$, an inverted U-shape relationship is depicted, that is, the Kuznets Curve hypothesis exists.

Regarding globalization, the advocate thought it reduced the disparate distribution of income in an economy. More specifically, there has been discussion on whether the rise of globalization is accompanied by an increase in inequality. The effects of globalization on inequality are becoming more and more politicized and disparate. Globalization is criticized for exacerbating inequality within and across nations[57,58]. Despite the fact that globalization may increase people's relative and absolute wages, some research indicates that there are definite winners and losers. Others contend that these assertions are demonstrably false, asserting that the collapse of national borders and the ensuing economic integration has lifted millions out of poverty and reduced inequality[59]. Incorporating globalization indices into equation (2.2), it becomes:

$$ineq = \theta_0 + \theta_1 inc + \theta_2 inc^2 + \Phi glob \quad (2.3)$$

The variables and parameters remained as earlier discussed while *glob* denotes globalization variables and Φ is the coefficient of globalization. Regarding environmental sustainability,

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two factors (exposure and vulnerability) dominantly determine the effects of environmental deterioration, such as air pollution and climate change, on wellbeing. Exposure is the presence of individuals, means of subsistence, species, or ecosystems, environmental functions, services, and resources, infrastructure, or economic, social, or cultural assets in locations and contexts where environmental deterioration may have a negative impact[60]. Vulnerability is defined as the propensity or predisposition to experience negative consequences and/or the inability to cope with or adjust in the event of exposure[61]. It is possible to be exposed but not vulnerable, hence exposure is generally a necessary but insufficient condition to be adversely affected by environmental degradation. For instance, even though a person's home is situated in a floodplain, they may have the resources to make structural changes to the building to lessen the risk of damage. Since they vary among population groups, exposure and vulnerability are equally crucial when considering the effects of environmental degradation. For instance, exposure and vulnerability in the context of climate change might interact to increase the physical danger and limit people's capacity for adaptation[62]. Integrating environmental sustainability indicators into equation (2.3), it becomes:

$$ineq = \theta_0 + \theta_1 inc + \theta_2 inc^2 + \Phi glob + \mathrm{B}env \qquad (2.4)$$

Equally, the variables and parameters remained as earlier discussed while *env* denotes environmental sustainability variables and B is the coefficient of environmental sustainability. The above model forms the theoretical basis of this study which is aimed towards investigating the interrelationship among globalization, environmental sustainability and income inequality in ECOWAS.

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2.6 Summary of Gaps in Literature Reviewed

The empirical review carried out showed diverse results from various research respectively, some of which discovered that globalization has an adverse effect on environmental sustainability, while some researchers were of opinion that globalization does not cause environmental degradation and others believed globalization brings about a reduction in environmental degradation. It is safe to say that the results from several studies carried out by the researchers were inconclusive. There are no stable findings as regards to the research which could be because of difference in methodology adopted, differences in data choice, and variation in the period of the study. This is, however, an important reason to further empirical studies to validate for ECOWAS. As stated above, there have been different research work on the impact and relationship between globalization and environmental sustainability as well as environmental sustainability and income inequality, however, this research is going to attempt to analyze the tripartite relationship among the three variables in ECOWAS. Only few research has being carried out when it comes to ECOWAS countries so it will be inappropriate to use the decision of other regions findings in ECOWAS thus the need for further empirical research.

Furthermore, most research work that has been carried out on globalization made use of trade openness as a proxy for measurement of globalization, while some made use of KOF as a proxy for globalization but for the cause of this research trade openness, financial openness and KOF globalization index which is a more appropriate proxy of globalization will be used as it captures all aspect of globalization including economic, financial, technology, political amongst others respectively.

Likewise, most research work that has been carried out on environmental sustainability made use of carbon emission as a proxy for measurement of environmental sustainability, but for the cause of this research carbon emission, ecological footprints and environmental

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sustainability index will be used as a proxy of environmental sustainability as it captures all aspect of environmental sustainability including carbon emission, green house, amongst others respectively.

Finally, the inability of some of these research work to cover more recent periods is also one of the flaws in the cause of their study. This research work pursues to fill these various gaps in literature.

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Chapter Three

Methodology

In this section, the study presents the methodology that will be used to achieve the objectives of this study alongside the research design, model specification, theoretical expectation, estimation method, and data source and description.

3.1 Research Design

The research design adopted for this study is the *ex-post facto* research design. Secondary data will be extracted from the database of international institution such as the World Bank Indicator and KOF institute, for the 24-year period which the study looks at.

3.2 Model Specification

3.2.1 Model for Estimating the Effect of Globalization on Environmental Sustainability

This study analyses how globalization has affected environmental sustainability in ECOWAS using the conceptual framework in the previous chapter and the theoretical framework of the Environmental Kuznets Curve (EKC) hypothesis. Because this relationship is an inverted-U scheme, it was hypothesized that in the early stages of economic development, an increase in income will cause poor environmental quality to worsen until it reaches a certain point, at which point the relationship between income and poor environmental quality turns negative. In conclusion, the EKC hypothesis depicts that economic growth will enable a nation to go from being developing to becoming developed[1]. Thus, if there is no environmental policy, expansion automatically raises the burden on pollution. But as affluence rises, so does demand for environmental quality. The income elasticity of the demand for environmental quality determines the net effect that the EKC reflects. Governments will respond to worsening pollution by tightening environmental policy if the income elasticity of demand

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for environmental quality is 1. As a result, the size and technique effects perfectly balance one another, producing neutral economic growth without alterations to the quality of the environment[2]. Scale, technology, and composition effects can be used to break down the consequences of trade openness on the environment[1,3]. The scale effect is the potential rise in emissions brought on by the general economic expansion brought on by trade openness. By utilizing clean industrial technology, the technological effect of trade liberalization is anticipated to reduce emission intensity. When nations specialize in the production in which they have a comparative advantage, the composition impact refers to the potential shift in economic structure.

Comparative advantage-driven trade, however, results in significantly diverse environmental outcomes. The Pollution Haven Hypothesis (PHH) predicts that areas with a comparative advantage in polluting industries will see a concentration of those businesses and a deterioration of the environment. Countries or regions with a comparative edge in clean sectors, however, will see a concentration of low-emission companies and an improvement in the environment. As a result, the road of growth for an open economy can be dirtier than the path of growth for a closed economy. However, if trade, foreign investment, innovation, and political system openness help to modernize the capital stock and allow the technology impact to overcome the scale effect, globalization may improve the environment in cities[4,5]. As a result, it is important to carefully consider how globalization may affect pollution. Following the theoretical hypothesis, the general form of the relationship among income, globalization and environment is stated functionally as:

$$env_{it} = f(inc_{it}, inc_{it}^2, glob_{it}) \qquad (3.1)$$

Afterwards, the study augments the empirical model by incorporating other economic variables such as financial development, institutional quality, and energy use as potential

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determinants of environmental pollutants[6,7,8,9,10]. Incorporating the variables into equation (3.1), the model becomes:

$$env_{it} = f(inc_{it}, inc_{it}^2, glob_{it}, fd_{it}, iq_{it}, eu_{it}) \quad (3.2)$$

In mathematical form, it is presented as follows:

$$env_{it} = \theta_0 + \theta_1 inc_{it} + \theta_2 inc_{it}^2 + \Phi glob_{it} + \theta_3 fd_{it} + \theta_4 iq_{it} + \theta_5 eu_{it} + \varepsilon_{it} \quad (3.3)$$

Where: *env* represents environmental quality such as carbon emission and ecological footprint; *inc* is income per capita measured by gross domestic product per capita; inc^2 denotes the square of income per capita; *glob* represents column vector of globalization variables like trade, foreign capital and globalization index; *fd* indicates financial development measured by domestic credit to private sector; *iq* is institutional quality; *eu* is energy use; θ_0 is constant; Φ, θ_{1-5} are parameter; *i* is country; *t* denotes time; ε is the disturbance term. From the equation, there is no relationship if $\theta_1 = \theta_2 = 0$. Meanwhile, if $\theta_1 < 0, \theta_2 = 0$ and/or $\theta_1 > 0, \theta_2 = 0$, the relationship is said to be monotonically reducing and/or increasing respectively. Also, if $\theta_1 < 0, \theta_2 > 0$, a U-shape relationship is represented. However, if $\theta_1 > 0, \theta_2 < 0$, an inverted U-shape relationship is depicted, that is, the Environmental Kuznets Curve hypothesis exists.

3.2.2 Model for Estimating the Effect of Globalization on Income Inequality

Following the theoretical model developed in the previous section, the empirical model that establishes the effect of globalization (*glob*) on income inequality (*ineq*) in ECOWAS is based on previous works[11,12,13]. As a result, this study identifies globalization as a factor in income inequality. Many people contend that to attain economic equality, globalization has introduced variables that affect economic activity. Following the current wave of globalization, Nobel Laureate Eric Maskin of Harvard University observed that as trade and

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global production increased, country-level inequality increased as well[14]. Additionally, inequality brought on by globalization is frequently seen as coming in two flavors, one of which is "least bad" than the other. In the "lesser-worse" variant, inequality is accepted as an inevitable byproduct of a nation's growing economic prosperity. According to the theory, one group of workers' salaries rise as a result of globalization, but not for other groups, increasing the wage gap. In the "worst" case, lower-skilled and lower-paid workers typically see their salaries decline as a result of a decline in the demand for their abilities, while higher-skilled workers see their wages rise. Meanwhile, this study incorporates macroeconomic variables such as primary school enrolment (*pse*), interest rate (*int*), financial development measured by domestic credit to private sector (*fd*) and income per capita (*inc*) following previous studies[11,12,14]. Thus, the model is specified as:

$$ineq_{it} = \varphi_0 + \Phi glob_{it} + \pi_1 pse_{it} + \pi_2 \text{int}_{it} + \pi_3 fd_{it} + \pi_4 inc_{it} + e_{it} \quad (3.4)$$

The variables remained as earlier defined, while $\varphi_0, \Phi, \pi_{1-4}$ are parameter estimates; *i* is country; *t* is time; and *e* is error term.

3.2.3 Model for Estimating the Effect of Environmental Sustainability on Income Inequality

The theoretical model solved in the last section of chapter two is employed for analyzing the effect of environmental sustainability on income inequality in ECOWAS. Also, previous studies give credence to globalization on its role towards reducing income inequality[15,16,17]. These studies consider income inequality as a function on environmental degradation while incorporating some other economic variables. In addition, to control the fact that environmental degradation (*env*) has great effect on inequality (*ineq*), exogenous factors [income per capita (*inc*), primary school enrolment (*pse*), interest rate (*int*), and financial

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development measured by domestic credit to private sector (*fd*)] are incorporated in the model as:

$$ineq_{it} = \gamma_0 + \mathrm{B}env_{it} + \gamma_1 inc_{it} + \gamma_2 pse_{it} + \gamma_3 \mathrm{int}_{it} + \gamma_4 fd_{it} + \nu_{it} \quad (3.5)$$

As earlier defined, the variables remain the same, whereas B is a vector of the parameters of environmental quality; γ_0, γ_{1-4} are parameter estimates; *i* denotes country; *t* is time; and ν is error term.

3.3 Theoretical Expectation

For environmental sustainability model, the study presumes a direct relationship between income and environmental degradation whereas an indirect link between income per capita squared and environmental sustainability. This is expected to align with the speculation of the EKC hypothesis. As for globalization, its coefficient is expected to be positive or negative depending on how economies take globalization whether it will benefit them or not. As for many developing countries, globalization is likely to hurt the environment as goods imported into the country are harmful product or simply turning the economy to a dumping site. Financial development is expected to relate negatively with environment. This is simply because high domestic credit to private sector would enable firms to adopt cleaner technology for their production. Likewise, institutional quality of a country is presumed to curtail environmental degradation. However, energy use will increase pollutants if such economy depends on fossil fuels.

As regards income inequality model, globalization is expected to reduce economic inequality with improved trade, financial inflow, innovation, and political system. As for environmental sustainability, it would reduce inequality in an economy. Government policy in terms of its spending is presumed to lessen economic inequality of an economy. An educated economy is presumed to create opportunities for its citizens, which will lessen economic inequalities.

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Likewise, a strong financial system will lead to a low-income inequality as it provides equal credit opportunities for everyone in such economy. Also, low interest rate will reduce income inequality. An increase in income is expected to reduce economic inequality.

3.4 Data Source and Description

Table 3.1: Data Description, Measurement and Sources

S/N	Variables	Description	Measurement	Data source
1	CO_2	Carbon emission measured by metric ton per capita is emissions stemming from the burning of fossil fuels and the manufacture of cement; they include carbon dioxide produced during consumption of solid, liquid, and gas fuels as well as gas flaring.	It is measured in metric ton per capita.	World Development Indicator (WDI) 2020.
2	*ECFT*	Ecological footprints measure the impact of human activities measured in terms of the area of biologically productive land and water required to produce the goods consumed and to assimilate the wastes generated.	It is measured in per capita.	World Development Indicator (WDI) 2020.
3	*GINI*	GINI represents income inequality measured in percentage, it measures the dispersion of income or distribution of wealth among the members of a population.	It is measured in percentage.	World Development Indicator (WDI) 2020.
4	*TRDPC*	Trade per capita measures exports and show the ratio between the total exports of goods and services and the population (inhabitants) as a whole.	It is measured in per capita.	World Development Indicator (WDI) 2020.
5	*FDI*	Foreign direct investment measured by net inflows % of GDP; it is an investment in the form of a controlling ownership in a business in one country by an entity based in another country.	It is measured in percentage.	World Development Indicator (WDI) 2020.
6	*KOFGI*	KOF globalization index measures the economic, social, and political dimensions of globalization.	It is measured in percentage.	KOF institute 2020.
7	*FD*	Financial development measured by domestic credit to private sector by banks.	It is measured in percentage.	World Development Indicator (WDI) 2020.

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8	*EU*	Energy intensity level of primary energy, it measures the level of energy use.	It is measured in percentage.	World Development Indicator (WDI) 2020
9	*IQ*	Institutional quality is a broad concept that captures law, individual rights and high-quality government regulation and services.	It is measured in percentage.	World Governance Indicator (WGI) 2020.
10	*INC*	Gross domestic products per capita, measured in current USD, shows a country's GDP divided by its total population.	It is measured in per capita.	World Development Indicator (WDI) 2020.

Source: Author (2022).

3.5 Estimation Methods: Cross-Sectional Dependence, Panel Unit Root, Panel Cointegration and Pooled Mean Group

The world's economy has become more interconnected, which has made it easier for economic shocks to spread from one economy to another. Consequently, interconnectedness between nations is conceivable. The cross-sectional dependence (CD) test from Pesaran is used to continue the study[18]. To guarantee accurate estimates and estimator effectiveness, the CD test is crucial. To further determine the stationarity characteristics of the variables, we used the panel unit root estimators by Levin, Lin & Chin; Breitung; and Im, Pesaran& Shin[19,20,21]. A co-integration test is necessary to determine the likelihood of a long-run relationship after the variables are stationary. The cointegration test by Kao was used in this study to look for co-integration between the variables[22].

Pesaran, Shin, and Smith propose two estimating procedures for growth regressions, the Mean Group (MG) and the Pooled Mean Group (PMG), that allow for greater parameter heterogeneity[23]. The PMG allows short-run coefficients, adjustment speed, and error variances to vary across countries while imposing common long-run coefficients. This estimator is best suited for panels with large T and N values. It does not impose slope homogeneity in the short run and allows for dynamics because it imposes homogeneity in the long run coefficients while allowing for heterogeneity in the short run coefficients and error

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variances, the Pooled Mean Group (PMG) estimator considers a lower degree of heterogeneity. The basic assumptions of the PMG estimator are: i) the error terms are serially uncorrelated and distributed independently of the regressors, i.e., the explanatory variables can be treated as exogenous; ii) the dependent and explanatory variables have a long run relationship; and iii) the long run parameters are consistent across countries. This estimator is also adaptable enough to accommodate long-run coefficient homogeneity across a single subset of regressors and/or countries. The stationarity characteristics of the variables i.e., I(0), and I(1), the presence of the cross sectional dependence and the probability value of the Hausman test carried out was used to compare the suitability of the PMG estimator to the MG estimator.

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Chapter Four

Results and Discussion of Findings

This section of the study covers the detailed empirical and econometric analyses of globalization, environmental sustainability, and income inequality in ECOWAS between 1996 and 2019. This analysis was carried out based on the formulated theoretical framework and specified empirical models in the previous section. The remaining sections in this chapter are divided into three parts. The descriptive analysis of the economic variables was presented in the first section. The second part of the chapter provides the empirical results according to the specific objectives. Discussion of findings was presented in the last section.

4.1 Descriptive Analysis

The summary statistics of the variables used to analyze the relationship among Globalization, Environmental Sustainability and Income Inequality in ECOWAS are presented in this section. The results of the summary statistics of income inequality, CO_2 emission (metric tons per capita), ecological footprints, trade per capita (current US$), foreign direct investment net inflows (% of GDP), KOF Globalization index, domestic credit to private sector by banks (% of GDP), energy intensity level of primary energy (MJ/$2017 PPP GDP), GDP per capita (current US$), general government final consumption expenditure per capita (current US$), inflation consumer prices (annual %), school enrollment primary (% gross), and institutional quality from 1996 to 2019. The summary statistic of income inequality, carbon emission and ecological footprint from 1996 to 2019 presented in Table 4.1 indicated that income inequality, carbon emission and ecological footprint have a mean value of 0.130, 0.320, and 1.339 respectively. The value indicates that there are no much differences between the two proxies of environmental sustainability namely carbon emission and ecological footprint. For in-depth analysis, Table 4.2 present the average value of each country in the ECOWAS

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region. From the table, the average value of Liberia with respect to income inequality is 0.156 being the highest value, directly followed by Mali with 0.146, and 0.141 for Niger and Guinea respectively, whilst having Togo, Guinea-Bissau, and Cabo Verde as the bottom three with the least values of 0.120, 0.117, 0.105 respectively. In terms of CO_2 emission metric tons per capita Cabo Verde (0.848), Nigeria (0.665), and Senegal (0.518) are the top three and the least three are Burkina Faso (0.130), Sierra Leone (0.099), and Niger (0.075) respectively. With regards to ecological footprints, Ghana (1.763), Cabo Verde (1.758), and Guinea (1.566) are the top three whilst having Gambia, The (1.084), Sierra Leone (0.070), and Togo (1.045) as the bottom three respectively.

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Table 4.1: Descriptive statistics

Sign	Variable Measurements	Mean	Std Dev	Maximum	Minimum	Kurtosis	Skewness	Obs.
gini	Income Inequality	0.130	0.019	0.169	0.084	-0.528	-0.085	360
co_2	CO_2 emissions (metric tons per capita)	0.320	0.238	1.182	0	1.848	1.416	358
ecft	Ecological Footprint	1.339	0.261	2.218	0.895	0.356	0.868	360
trdpc	Trade per capita (current US$)	563.9	695.3	4229.5	0	11.182	3.159	360
fdi	Foreign direct investment, net inflows (% of GDP)	4.251	9.687	103.3	-2.545	61.467	7.329	356
kofgi	KOF Globalization Index	45.544	7.414	61.634	25.622	-0.231	-0.179	360
fd	Domestic credit to private sector by banks (% of GDP)	14.226	11.921	65.278	0	6.068	2.260	353
eu	Energy intensity level of primary energy (MJ/$2017 PPP GDP)	6.377	3.068	15.820	2.6	0.328	1.053	300
inc	GDP per capita (current US$)	911.1	745.644	3740.4	138.7	3.551	1.907	356
gs	General government final consumption expenditure per capita (current US$)	106.9	119.366	701.6	4.273	12.049	3.360	306
inf	Inflation, consumer prices (annual %)	5.869	7.800	50.734	-3.503	10.264	2.717	333
pse	School enrolment, primary (% gross)	87.523	23.242	143.7	28.008	-0.369	-0.136	295
iq	Institutional Quality	-0.671	0.448	0.377	-1.870	-0.240	0.240	360

Note: Std Dev. – standard deviation; Obs. - observation.
Source: Author's computation 2022.

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Table 4.2: Average of Globalization, Environmental Sustainability, and Income Inequality (1996-2019)

S/N	Country	Income Inequality	CO2 emissions (metric tons per capita)	Ecological Footprint	Trade per capita (current US$)	Foreign direct investment, net inflows (% of GDP)	KOFGlobalization Index	GDP per capita (current US$)	General government final consumption expenditure per capita(current US$)	Institutional Quality
1	Benin	0.127	0.410	1.309	466.84	0.788	44.30	886.30	91.61	-0.468
2	Burkina Faso	0.128	0.130	1.204	260.94	1.049	43.62	533.08	85.70	-0.370
3	Cabo Verde	0.105	0.848	1.758	2616.71	6.587	47.15	2595.31	615.95	0.258
4	Cote d'Ivoire	0.125	0.356	1.172	891.63	1.389	49.17	1580.23	209.03	-0.736
5	Gambia, The	0.121	0.229	1.084	337.31	4.307	47.11	678.40	62.79	-0.545
6	Ghana	0.126	0.429	1.763	845.52	4.574	54.53	1130.69	100.80	-0.121
7	Guinea	0.141	0.214	1.566	439.30	3.284	41.38	605.39	74.22	-0.984
8	Guinea-Bissau	0.117	0.155	1.354	254.16	1.701	36.36	491.69	55.67	-1.225
9	Liberia	0.156	0.203	1.243	n.a	24.749	43.88	513.27	n.a.	-1.272
10	Mali	0.146	0.167	1.494	343.46	2.600	44.93	584.51	90.58	-0.664
11	Niger	0.141	0.075	1.532	159.22	3.622	37.80	391.51	66.54	-0.727
12	Nigeria	0.134	0.665	1.185	592.55	1.465	52.14	1634.72	102.37	-1.021
13	Senegal	0.132	0.518	1.308	605.66	2.009	55.10	1078.79	146.48	-0.207
14	Sierra Leone	0.137	0.099	1.070	232.71	5.996	37.99	380.72	38.15	-1.039
15	Togo	0.120	0.295	1.045	412.73	3.065	47.72	516.01	70.30	-0.938

Source: Author's computation 2022.

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With respect to trade per capita, the maximum value amounted to US$4,229.5 million while the minimum value equals US$0 accordingly, among the countries in ECOWAS region the top three countries with the highest trading activities per population are Cabo Verde (US$2,616.71 million), Cote d'Ivoire (US$891.63 million), and Ghana (US$845.52 million), whereas the bottom three countries with the least trading activities per population are Guinea-Bissau (US$ 254.16 million), Sierra Leone (US$232.71 million) and Niger (US$159.22 million) respectively. Based on foreign direct investment, the top three countries with the highest foreign direct inflows are Liberia (24.749%), Cabo Verde (6.587%), and Sierra Leone (5.996%) respectively, while the bottom three countries are Cote d'Ivoire (1.389%), Burkina Faso (1.049%), and Benin (0.788%) respectively. On the ground of KOF Globalization index the top three countries with the highest values are Senegal (55.10%), Ghana (54.53%) and Nigeria (52.14%) accordingly, while the bottom three countries with the least value are Sierra Leone (37.99%), Niger (37.80%), Guinea-Bissau (36.36%) respectively.

Asides this, the mean domestic credit to private sector by banks is 14.226% and the maximum and minimum values are 62.278% and 0% respectively. Regarding other covariates, the average of energy intensity, GDP per capita, general government final consumption expenditure, inflation, primary school enrollment, and institutional quality are 6.377, US$911.1, US$ 106.9, 5.869%, 87.523%, and -0.671. This notwithstanding, the maximums in the region are 62.278%, 15.820, US$3740.4, US$701.6, 50.734%, 143.7% and 0.377 respectively, while the minimums are 0%, 2.6, US$ 138.7, US$4.273, -3.503%, 28.008%, -1.870 respectively.

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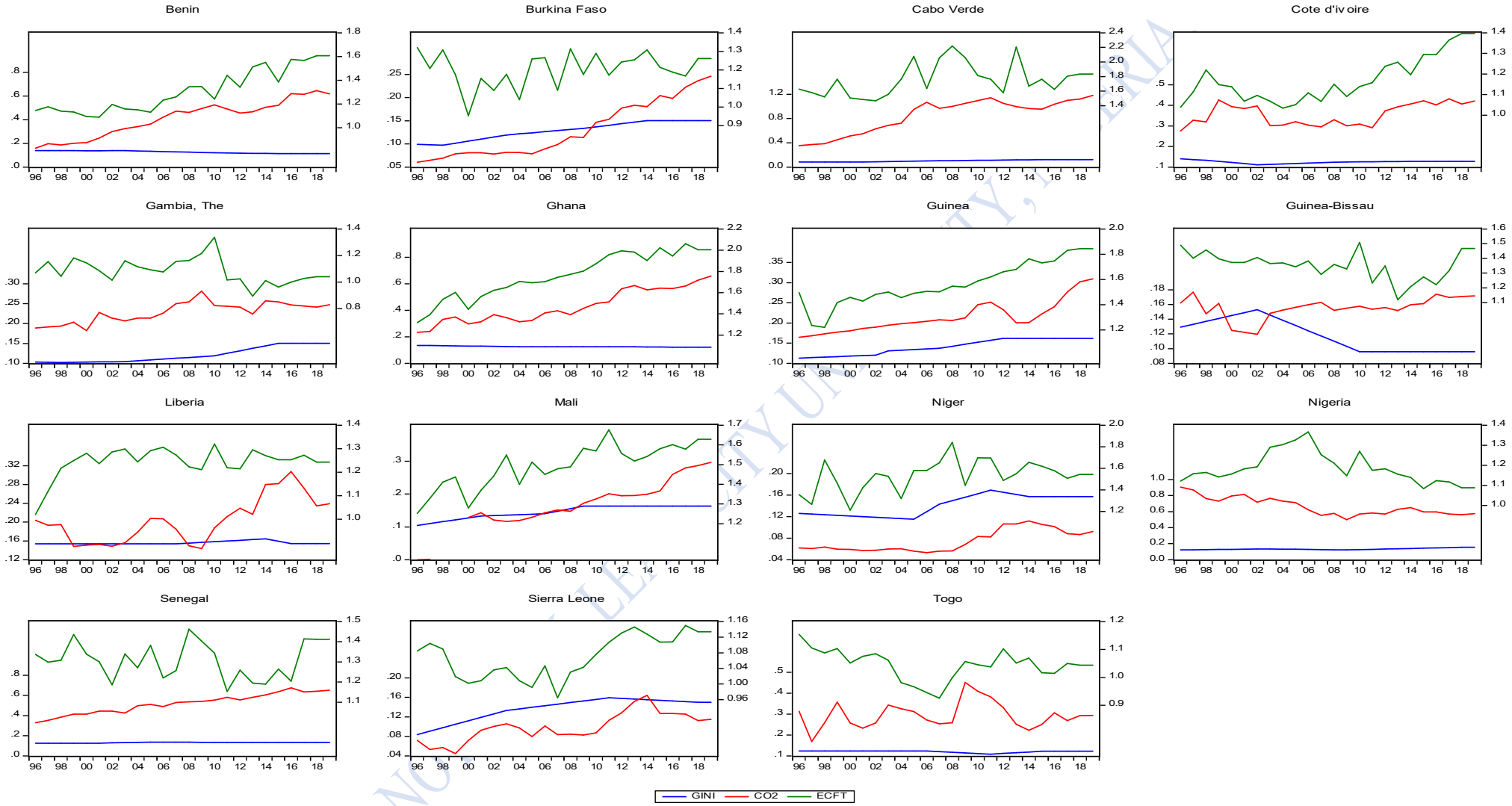

Figure 4.1: Plot of Income Inequality, Carbon Emission and Ecological Footprints for ECOWAS
Source: Author's computation 2022

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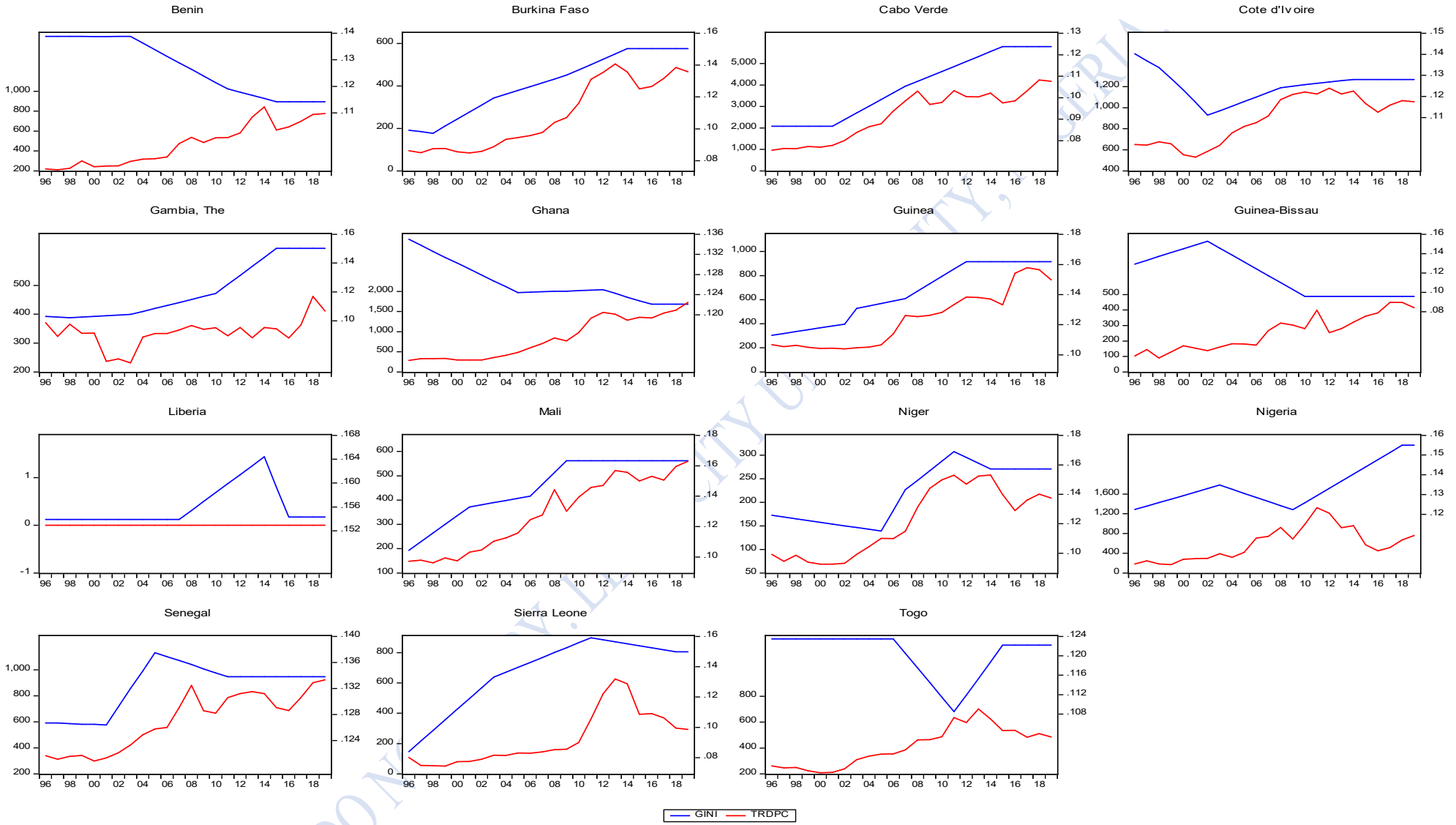

Figure 4.2: Plot of Income Inequality and Trade per capita for ECOWAS
Source: Author's computation 2022

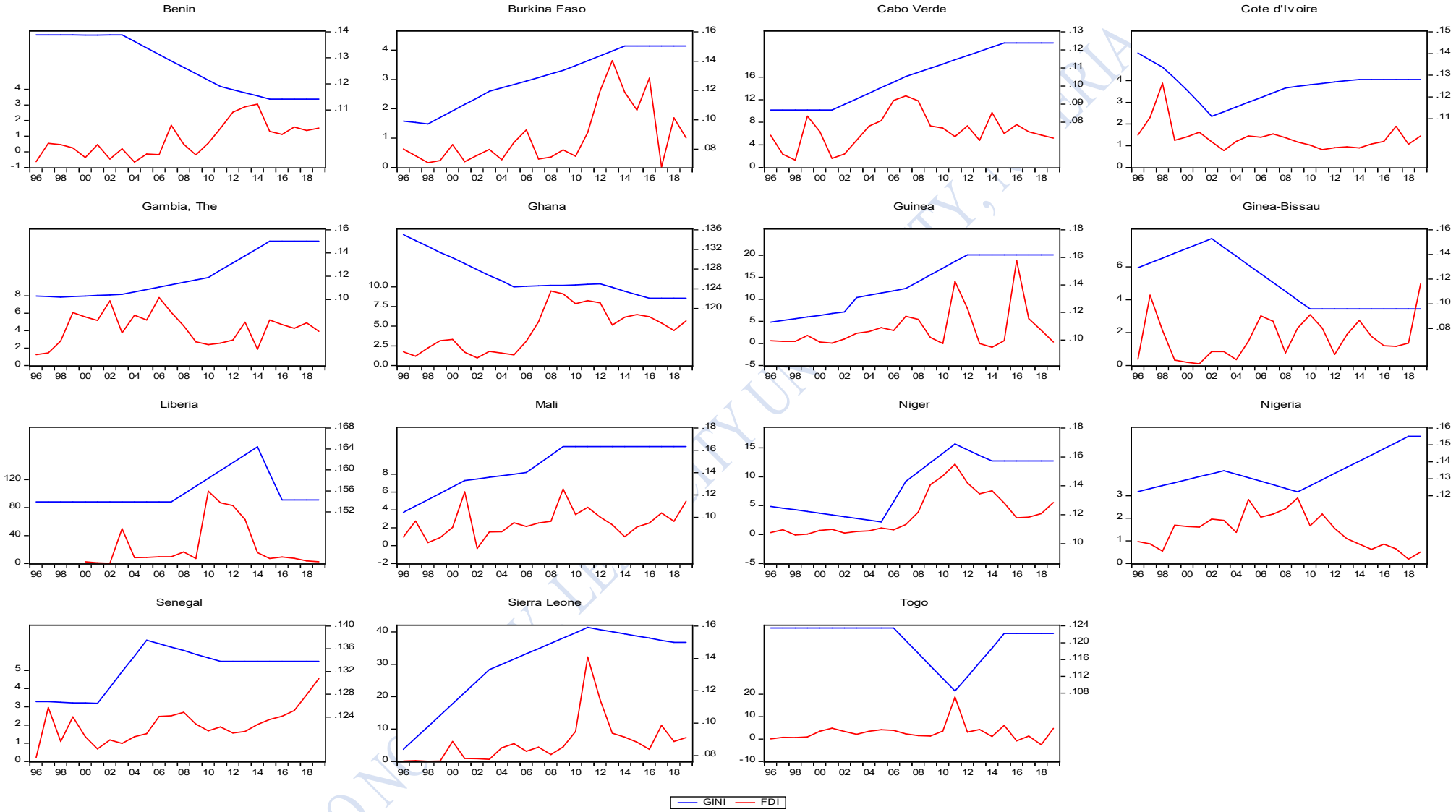

Figure 4.3: Plot of Income Inequality and FDI for ECOWAS

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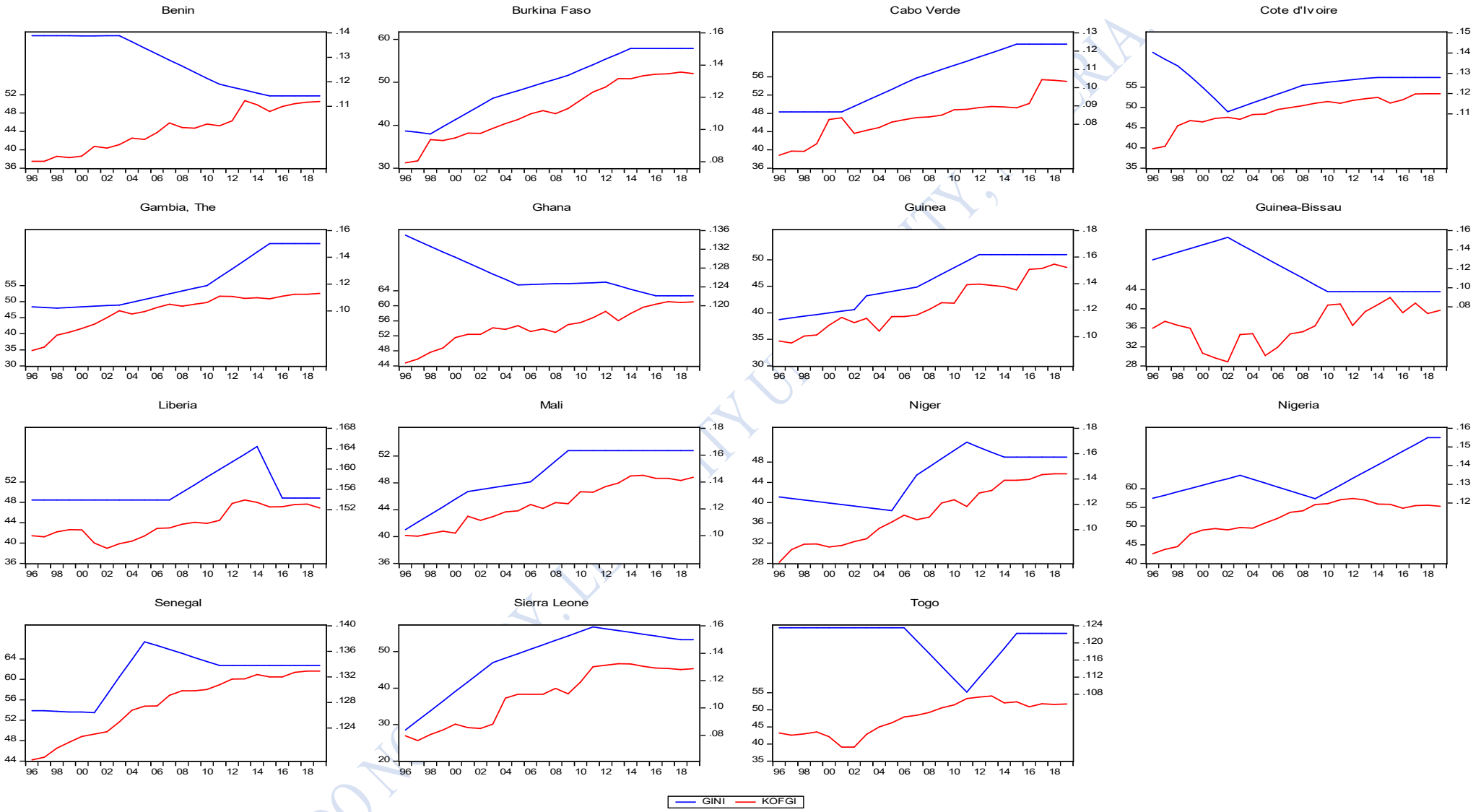

Figure 4.4: Plot of Income Inequality and KOFGI for ECOWAS

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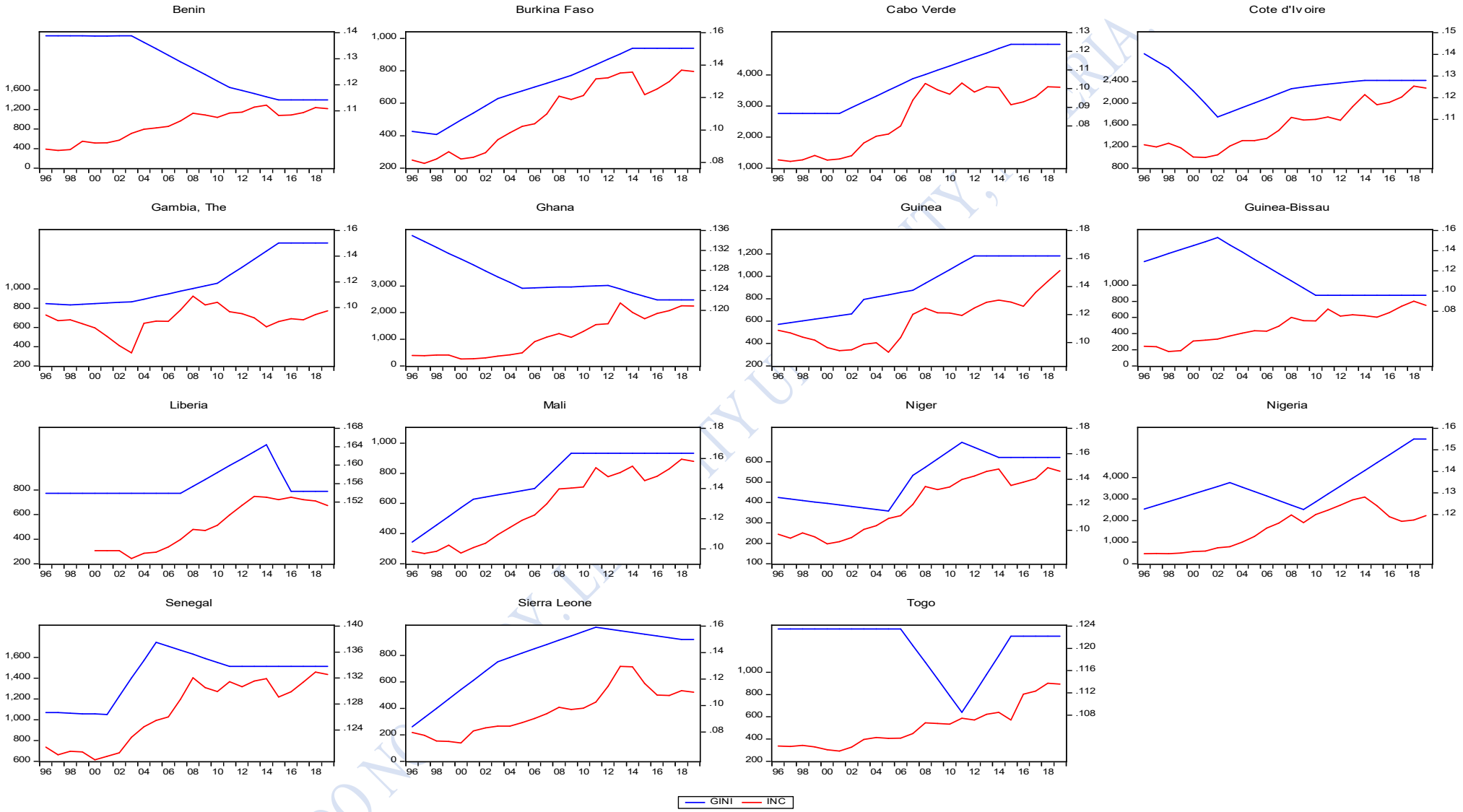

Figure 4.5: Plot of Income Inequality and GDP Per Capita for ECOWAS

Among the countries in ECOWAS region Sierra Leone has the least average of GDP per capita and the country with the highest mean of GDP per capita is Cabo Verde, followed by Nigeria and Cote d'Ivoire. Similarly, the country with the least average of general government final consumption per capita is Sierra Leone while the country with the highest mean is Cabo Verde followed by Cote d'Ivoire and Senegal respectively. Likewise, Nigeria has the least average of institutional quality and the country with the highest average being Cabo Verde. From Table 4.1, the summary statistics showed that income inequality, KOF globalization index and primary school enrollment are left skewed while others are right skewed. Also, income inequality, carbon emission, ecological footprints, KOF globalization index, energy intensity level, primary school enrollment, and institutional quality are platykurtic i.e., their distribution have values less (<3) while the remaining indices are leptokurtic i.e., their distribution have values (>3).

The time-series plots of indicators for the 15 countries in ECOWAS are presented in Figures 4.1, 4.2, 4.3, 4.4 and 4.5. Specifically, Figure 4.1 shows the trend movement of income inequality, carbon emission and ecological footprints. The time-series plots of carbon emission, ecological footprints, and income inequality flow in a similar manner for some of the countries. The series movement of carbon emission and ecological footprints in Benin, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Mali, Senegal, Sierra Leone were somewhat similar as they all depicted slow rise in the first few years, followed by fluctuations and afterwards slides upwards for the remaining period while the movement of income inequality was steep except in the cases of Burkina Faso, Gambia, Guinea, Guinea-Bissau, Mali, Niger, and Sierra Leone.

Figure 4.2 shows the trend movement between income inequality and trade per capita. Trade per capita for Benin, Cabo Verde, Cote d'Ivoire, Ghana, Mali, and Senegal is characterized by upward and downward fluctuations at different time intervals, followed by an increase in

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the concluding period. In the case of the remaining countries the trend of trade per capita is characterized by a gradual rise in the initial stage followed by a decline in the concluding stage except in the case of Liberia where trade per capita was steeped throughout the period. Consequently, for income inequality in the case of Burkina Faso, Cabo Verde, Gambia, Guinea, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo the trends are all characterized by a steep trend in the early stage followed by a gradual increase over the years then lastly a steep trend in the concluding period. As regards the remaining countries the trends are all characterized by a steep trend in the early stage followed by a gradual decrease over the years then lastly a steep trend in the concluding period.

Figure 4.3 shows the trend movement between income inequality and foreign direct investment. Foreign direct investment for Benin, Cote d'Ivoire, Ghana, Guinea-Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo is characterized by upward and downward fluctuations at different time intervals, followed by an increase/upward trend in the concluding period. In the case of the remaining countries the trend of foreign direct investment is characterized by a fluctuation in the initial stage followed by a decline in the concluding stage.

Figure 4.4 shows the trend movement between income inequality and KOF globalization index. KOF globalization index for Benin, Cote d'Ivoire, Gambia, Ghana, Guinea-Bissau, Mali, Niger, Senegal, Sierra Leone, and Togo is characterized by upward and downward fluctuations at different time intervals, followed by an increase in the concluding period. In the case of the remaining countries the trend of KOF globalization index is characterized by a fluctuation in the initial stage followed by a decline in the concluding stage.

Figure 4.5 shows the trend movement between income inequality and GDP per capita. GDP per capita for Cabo Verde, Gambia, Guinea, Nigeria, and Togo is characterized by upward

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and downward fluctuations at different time intervals, followed by an increase in the concluding period. In the case of the remaining countries the trend of KOF globalization index is characterized by a fluctuation in the initial stage followed by a decline in the concluding stage.

4.2 Test of Hypotheses

This section presents the empirical results regarding the specific objectives in the following three sub-sections. Before the presentation of results of the stated specific objectives, pre-estimation test such as correlation analysis for the detection of multicollinearity problem, scattered charts, unit roots, and cointegration are examined to decide the appropriate estimation techniques for each objective. The estimation outcomes are presented in the following sub-sections.

4.2.1 Analysis of the First Objective

In this sub-section, the research study reports the empirical results relating to the effect of globalization on environmental sustainability in ECOWAS.

4.2.1.1 Correlation Analysis and Scatter Plots

Table 4.3 presents the partial correlation coefficients of the variables relating to the relationship between globalization and environmental sustainability in ECOWAS. The coefficient of correlation result shows that globalization indices (such as trade per capita, foreign direct investment, and KOF globalization index) has positive level of association with environmental sustainability indices (such as carbon emission and ecological footprints) except in the case of carbon emission and foreign direct investment where a negative relationship exists. A pictorial view of the correlation coefficients is depicted in the scatter graph of the variables in Figures 4.6 a-c and 4.7 a-c. The scatter plot between carbon emission and trade per capita as well as carbon emission and KOF globalization index have a

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strong positive relationship, while that of carbon emission and foreign direct investment have a moderate negative relationship. Figure 4.7 depicts that the relationship between ecological footprints and trade per capita have a strong positive relationship, while that of ecological footprints and foreign direct investment have a weak positive relationship and lastly, there exists a moderate positive relationship between ecological footprints and KOF globalization index.

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Table 4.3: Correlation Matrix

	ecft	trdpc	fdi	kofgi	fd	eu	inc	inc2	iq
co2	0.355	0.792	-0.010	0.593	0.690	-0.340	0.812	0.770	0.481
ecft	1	0.517	0.057	0.167	0.377	-0.341	0.398	0.407	0.445
trdpc		1	0.009	0.422	0.829	-0.447	0.894	0.918	0.566
fdi			1	0.055	0.030	0.266	0.010	0.022	-0.053
kofgi				1	0.460	-0.431	0.571	0.410	0.360
fd					1	-0.358	0.705	0.728	0.603
eu						1	-0.425	-0.358	-0.744
inc							1	0.954	0.461
inc^2								1	0.442

Note: co_2 - Carbon emission (metric tons per capita), ecft- Ecological Footprint, trdpc- Trade per capita (current US$), fdi- Foreign direct investment, net inflows (% of GDP), kofgi- KOF Globalization Index, fd- Domestic credit to private sector by banks (% of GDP), eu- Energy intensity level of primary energy (MJ/$2017 PPP GDP), inc- GDP per capita (current US$), inc^2 – square GDP per capita (current US$), iq- Institutional Quality.
Source: Author's computation 2022.

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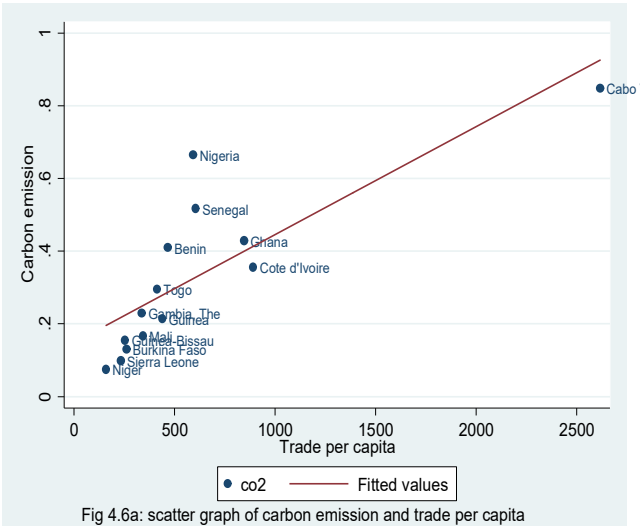

Fig 4.6a: scatter graph of carbon emission and trade per capita

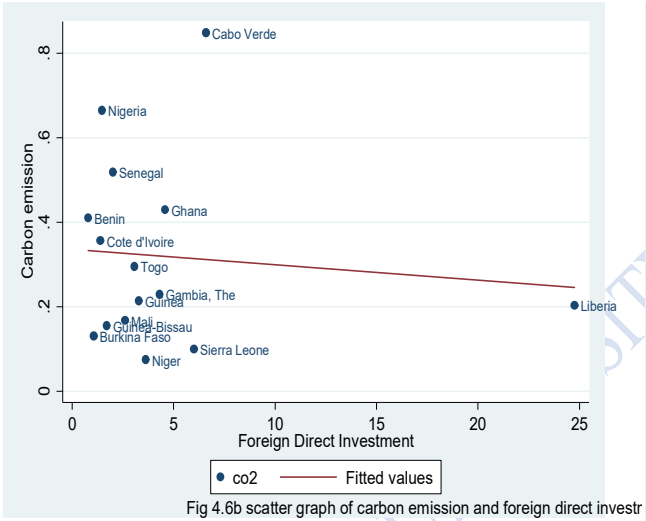

Fig 4.6b scatter graph of carbon emission and foreign direct investr

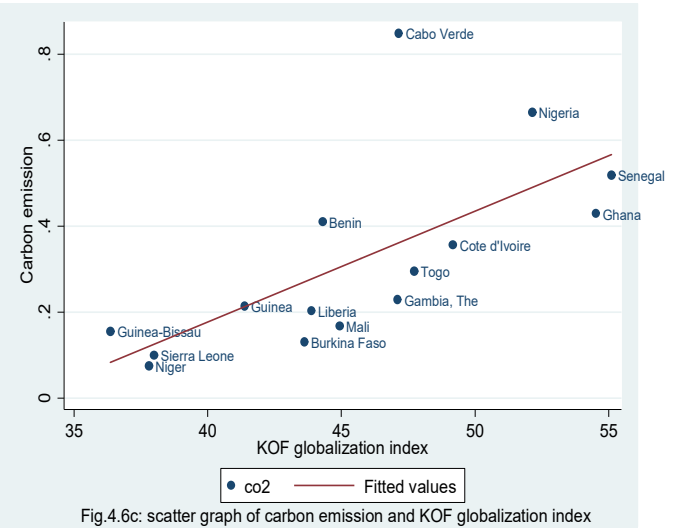

Fig.4.6c: scatter graph of carbon emission and KOF globalization index

Figure 4.6(a-c): Scatter Plots of Carbon Emission and Globalization

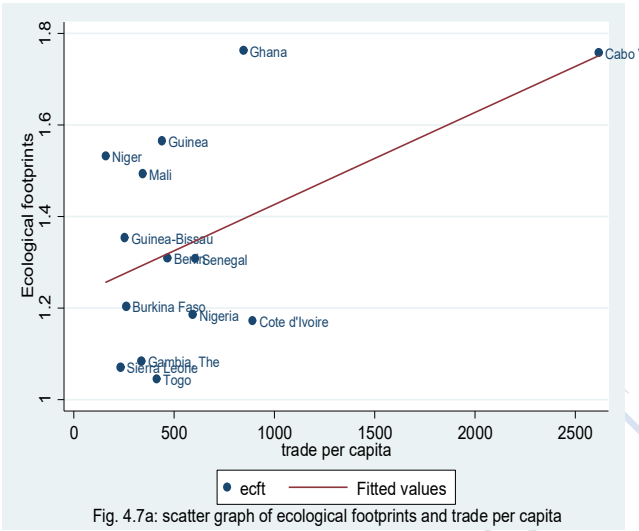

Fig. 4.7a: scatter graph of ecological footprints and trade per capita

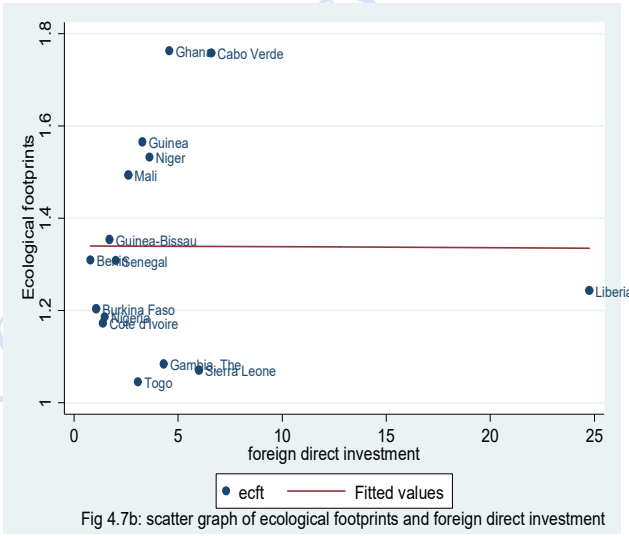

Fig 4.7b: scatter graph of ecological footprints and foreign direct investment

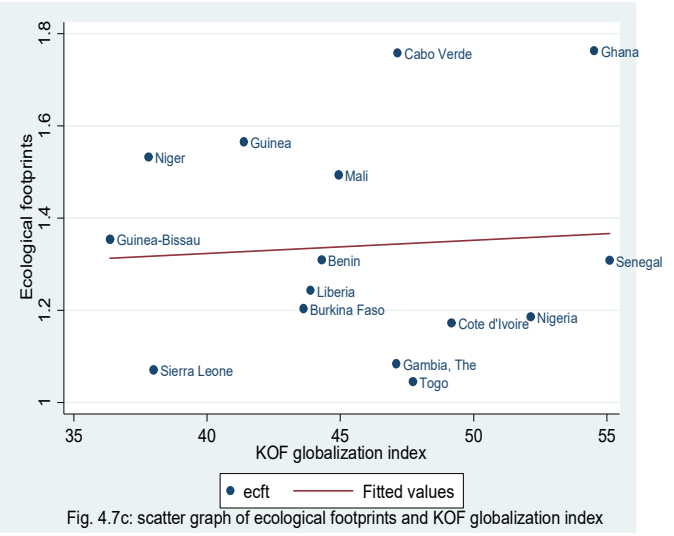

Fig. 4.7c: scatter graph of ecological footprints and KOF globalization index

Figure 4.7(a-c): Scatter Plots of Ecological Footprint and Globalization
Source: Author's computation 2022

4.2.1.2 Cross-sectional Dependence, Stationary and Cointegration Tests

The results of cross-sectional dependence test are presented in Table 4.4. The test statistics were performed for fifteen West African countries (Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo), for a period of 24 years (1996–2019). The Breusch-Pagan LM test results presented in Table 4.4 confirm the rejection of null hypotheses of no correlation at conventional significance levels. Also, the Pesaran scaled LM test results are asymptotically standard normal and the statistical values strongly reject the null hypotheses at 5% significance level. As for the test statistic values of standard normal Pesaran CD test, their statistical values are significantly below the values of LM tests, and they still reject the null hypotheses at 0.05 critical values.

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Table 4.4: Cross-Sectional Dependence Test Results (d.f. = 105)

	Statistics	**Probability**
Carbon emission models		
Model 1: co_2 inc inc^2 trdpc fd iq eu		
Breusch-Pagan LM	468.3061	0.0000
Pesaran scaled LM	25.07050	0.0000
Pesaran CD	13.52932	0.0000
Model 2: co_2 inc inc^2fdi fd iq eu		
Breusch-Pagan LM	360.7961	0.0000
Pesaran scaled LM	17.65161	0.0000
Pesaran CD	9.300586	0.0000
Model 3: co_2 inc inc^2 kofgi fd iq eu		
Breusch-Pagan LM	569.1208	0.0000
Pesaran scaled LM	32.02738	0.0000
Pesaran CD	17.07827	0.0000
Ecological Footprint models		
Model 4: ecft inc inc^2 trdpc fd iq eu		
Breusch-Pagan LM	320.7069	0.0000
Pesaran scaled LM	14.88519	0.0000
Pesaran CD	8.282857	0.0000
Model 5: ecft inc inc^2 fdi fd iq eu		
Breusch-Pagan LM	402.8420	0.0000
Pesaran scaled LM	20.55305	0.0000
Pesaran CD	4.102487	0.0000
Model 6: ecft inc inc^2 kofgi fd iq eu		
Breusch-Pagan LM	490.8612	0.0000
Pesaran scaled LM	26.62695	0.0000
Pesaran CD	6.260194	0.0000

Note: co_2 – Carbon emission (metrics ton per capita); inc - GDP per capita (current US$); inc^2 – square of GDP per capita (current US$); trdpc- Trade per capita (current US$); fdi - Foreign direct investment, net inflows (% of GDP); kofgi – KOF Globalization Index; fd - Domestic credit to private sector by banks (% of GDP); iq - Institutional Quality; eu - Energy intensity level of primary energy; ecft - Ecological Footprint.
Source: Author's computation 2022.

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4.2.1.3 Unit Root and Cointegration Tests

Furthermore, the panel unit root and cointegration tests were reported. Concerning Table 4.5, it shows the unit root test results using Levin, Lin, and Chin (LLC), Breitung (Breit) and Im, Pesaran & Shin (IPS) statistics approaches. As reported in the table, the methods confirmed that the two indices of environmental sustainability, carbon emission (CO_2) and ecological footprints (ecft) are stationary at levels I (0). Among the three proxies for globalization, KOF globalization index (kofgi) and trade per capita (trdpc) are integrated at the first difference I(1) while foreign direct investment (fdi) is stationary at levels I(0). On the other hand, for energy intensity of primary energy (eu), the unit root results are mixed using the three estimators and stationary at first difference I(1). Domestic credit to private sector (fd),) GDP per capita (inc), square of GDP per capita (inc^2), and institutional quality (Iq) are all integrated at first difference I (1) respectively.

Table 4.6 presents the KAO Residual test for cointegration. Within the conventional probability test criteria, Table 4.6 revealed that a rejection of the null hypotheses of no cointegration for the six models at 5% level of significance. This means that there exists a long-run relationship among the regressand and regressors across all the estimated models in the study. Thus, it confirms that the presence of co-integration or a long-run relationship between globalization and environmental sustainability in ECOWAS.

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Table 4.5: Panel Unit Root Test Results

Variables	Variable Description	Levels			1st Difference			Decision
		LLC	Breit	IPS	LLC	Breit	IPS	
co_2	Carbon emission	-2.725***	-1.9829**	-4.378***	-	-	-	I(0)
ecft	Ecological Footprints	-4.617***	-3.191***	-5.1901***	-	-	-	I(0)
eu	Energy intensity level of pry energy	-2.649***	0.2723	-0.4609	-	-4.910***	-5.728***	I(1)
fd	Domestic credit to private sector by banks	-0.2556	0.7949	-0.9451	-10.491***	-3.551***	-9.677***	I(1)
fdi	Foreign direct investment	-3.5095***	-4.0637***	-4.8123***	-	-	-	I(0)
inc	GDP per capita	1.2296	-1.1811	2.1404	-9.948***	-7.1586**	-8.432***	I(1)
inc_2	Square of GDP per capita	1.1507	-1.2048	2.0458	-10.776***	-7.985**	-9.119***	I(1)
iq	Institutional quality	-0.6402	1.664	0.2721	-14.299***	-11.72***	-12.588***	I(1)
kofgi	KOF globalization index	-1.8275	0.598	-1.3729	-12.878***	-10.135**	-12.144***	I(1)
trdpc	Trade per capita	1.17453	-1.2746	0.8392	-10.493***	-6.614***	-9.761***	I(1)

Note: LL denotes Levin, Lin & Chin 2002; Breit represents Breitung 2001; IPS denotes Im, Pesaran & Shin 2003; ***, ** & * denote 1%, 5% & 10% significance levels.
Source: Author's computation 2022.

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Table 4.6: KAO Residual Test for Cointegration

Hypothesis 1	**Statistics**	**Probability**
Carbon emission models		
Model 1: co_2 inc inc^2 trdpc fd iq eu	-2.6162	0.0044
ADF		
Residual variance	0.0091	
HAC variance	0.0100	
Model 2: co_2 inc inc^2 fdi fd iq eu	-2.6051	0.0046
ADF		
Residual variance	0.0096	
HAC variance	0.0104	
Model 3: co_2 inc inc^2 kofgi fd iq eu	-3.2843	0.0005
ADF		
Residual variance	0.0093	
HAC variance	0.0105	
Ecological Footprint models		
Model 4: ecft inc inc^2 trdpc fd iq eu	-7.1298	0.0000
ADF		
Residual variance	0.0057	
HAC variance	0.0027	
Model 5: ecft inc inc^2 fdi fd iq eu	-6.5395	0.0000
ADF		
Residual variance	0.0054	
HAC variance	0.0029	
Model 6: ecft inc inc^2 kofgi fd iq eu	-6.5446	0.0000
ADF		
Residual variance	0.0054	
HAC variance	0.0024	

Note: co_2 – Carbon emission (metrics ton per capita); inc - GDP per capita (current US$); inc^2 – square of GDP per capita (current US$); trdpc- Trade per capita (current US$); fdi - Foreign direct investment, net inflows (% of GDP); kofgi – KOF Globalization Index; fd - Domestic credit to private sector by banks (% of GDP); iq - Institutional Quality; eu - Energy intensity level of primary energy; ecft - Ecological Footprint.
Source: Author's computation 2022.

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4.2.1.4 Short Run and Long Run Parameter Estimates

The empirical result of the effects of globalization on environmental sustainability in ECOWAS region using the pooled mean group estimator was discussed in this section. The null hypotheses of Hausman tests in Table 4.7, indicate that the difference in coefficients of mean group and pooled mean group not being systematic are not rejected at 5% level of significance. It therefore signifies the suitability of pooled mean group as the appropriate estimator to test the research hypothesis. Environmental sustainability as the outcome variable was measured by carbon emission and ecological footprints. Accordingly, two models were estimated, and they are labeled 1, 2, 3, 4, 5, and 6. The selection of optimal lag lengths on the variables were selected automatically using the Bayesian Information Criterion (BIC) after setting it at three in order to ensure sufficient degree of freedom. The most common lag across the fifteen countries in ECOWAS is one for each variable of interest. Table 4.7 presents the summary of short-run and long-run parameter estimates of the pooled mean group or panel autoregressive distributed - ARDL (1, 1, 1, 1, 1, 1). From the table, the coefficients of error correction term are found to be negative and statistically significant at the conventional level. Specifically, the coefficients of the error correction term are -0.2874, -0.1900, -0.1732, -0.5265, -0.4756, and -0.5257, and the probability values of their t-statistic is less than 1% except for -0.1732 that was significant at 5%. It implies that the empirical models of globalization on environmental sustainability correct their short-run disequilibrium by 28.7%, 19%, 17.3, 52.7%, 47.6%, and 52.6% speed of adjustment in order to return to the long run equilibrium. This further confirms that there exists a long-run relationship between globalization and environmental sustainability in ECOWAS region. Thus, it confirmed that the models' equilibrium nature is valid in the long run[1].

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Table 4.7: Pooled Mean Group Estimates of Globalization and Environmental Sustainability

Variables	**Dependent Variable:** Environmental Sustainability					
	Carbon Emission			**Ecological Footprint**		
	1	2	3	4	5	6
Short-Run Estimates						
ECT	-0.2874***	-0.1900***	-0.1732**	-0.5265***	-0.4756***	-0.5257***
	(0.0795)	(0.0720)	(0.0735)	(0.0997)	(0.1038)	(0.1109)
D(income growth(-1))	0.5238	2.4812	1.5625	-0.2664	-0.4259	0.1415
	(1.4297)	(1.9610)	(1.3319)	(0.8796)	(0.6709)	(0.8402)
D(square of income growth(-1))	-0.5869	-0.2153	-0.1298	0.0219	-0.0362	0.0083
	(0.1064)	(0.1592)	(0.1014)	(0.0656)	(0.0509)	(0.0619)
D(trade openness(-1))	0.0205	-	-	-0.0925	-	-
	(0.0931)	-	-	(0.0563)	-	-
D(financial openness(-1))	-	-0.0057	-	-	-0.0060*	-
	-	(0.0037)	-	-	(0.0034)	-
D(KOF globalization index(-1))	-	-	0.0161**	-	-	-0.0005
	-	-	(0.0071)	-	-	(0.0039)
D(domestic credit to private sector(-1))	-0.0077**	-0.0115***	-0.0074**	0.00315	0.0028	0.0020
	(0.0033)	(0.0038)	(0.0033)	(0.0022)	(0.00179)	(0.0024)
D(institutional quality(-1))	0.0646	0.5008	0.0556	-0.0019	0.0385	0.03337
	(0.0857)	(0.0788)	(0.0725)	(0.0420)	(0.0424)	(0.4496)
D(energy use(-1))	0.6309***	0.7985	0.8076	-0.0169	-0.0363	0.0624
	(0.2278)	(0.2282)	(0.2139)	(0.0991)	(0.0926)	(0.1072)
Long-Run Estimates						
income growth	-2.1358***	-4.1012***	-7.8311***	-0.5212***	-0.2557**	-0.2045
	(0.6512)	(1.0601)	(1.4747)	(0.1704)	(0.0127)	(0.1300)
square of income growth	0.1426***	0.3478***	0.668***	0.0441***	0.0302***	0.0264**
	(0.0456)	(0.0870)	(0.1189)	(0.0120)	(0.0100)	(0.0130)
trade openness	0.7328***	-	-	0.1054***	-	-
	(0.1084)	-	-	(0.0328)	-	-
Financial openness	-	0.0503***	-	-	0.0085***	-
	-	(0.0064)	-	-	(0.0025)	-
KOF globalization index	-	-	-0.0093	-	-	-0.0001
	-	-	(0.0124)	-	-	(0.0023)
domestic credit to private sector	0.0213***	0.0384***	0.0360***	-0.0036***	-0.0014	-0.0014***
	(0.0052)	(0.0036)	(0.0059)	(0.0013)	(0.0011)	(0.0014)
institutional quality	0.0275	-0.2739	0.1554	0.9018	-0.0361	-0.1204***
	(0.1681)	(0.1839)	(0.1700)	(0.0592)	(0.0617)	(0.0269)
energy use	0.3213**	-0.3784**	-1.0897***	0.1408***	0.1153**	0.0099
	(0.1515)	(0.1649)	(0.1746)	(0.0498)	(0.0495)	(0.0357)
Constant	0.3199***	1.9169***	4.0303**	0.5604***	0.2311***	0.2394***
	(0.0739)	(0.7017)	(1.6753)	(0.1140)	(0.0614)	(0.0584)
Log Likelihood	410.74	445.80	422.06	552.08	596.64	593.92
Hausman Test (Prob.)	4.45(0.616)	4.08(0.629)	4.96(0.603)	5.24(0.513)	3.95(0.683)	2.22(0.899)
Country	14	15	15	15	15	15
Observations	321	339	339	322	340	340

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.10.
Source: Author's computation 2022

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As regards the short-run coefficients, the parameters of lag one of trade openness on carbon emission is positive and not significant at 5% level while that of trade openness on ecological footprints is negative and not significant at 5% level this implies that the effects of trade openness on carbon emission and ecological footprints in the short run are not statistically confirmed. However, in the long run the parameters of lag one of trade openness on carbon emission and ecological footprint is positive and statistically significant at 1% level. It means that there exists a positive relationship between trade openness on carbon emission and ecological footprints in ECOWAS region. This further implies that an increase in trade openness will lead to a corresponding increase in carbon emission and ecological footprints and this will give rise to further degradation of the environment and poor environmental sustainability. A 10% change in trade openness on carbon emission and ecological footprints in the long run increases by 7.33% and 1.05% respectively. The implication is that trade openness has significant impact on carbon emission and ecological footprints in the long run in ECOWAS region.

As regards the short-run coefficients, the parameters of lag one of financial openness on carbon emission is negative and not significant at 5% level while that of financial openness on ecological footprints is negative and significant at 10% level this means the effects of financial openness on carbon emission in the short run is not statistically confirmed while that of financial openness on ecological footprints in the short run is statistically confirmed. However, in the long run the parameters of lag one of financial openness on carbon emission and ecological footprint is positive and statistically significant at 1% level. It means that there exists a positive relationship between financial openness on carbon emission and ecological footprints in ECOWAS region. This further implies that an increase in financial openness will lead to a corresponding increase in carbon emission and ecological footprints and this will give rise to further degradation of the environment and poor environmental sustainability. A

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10% change in financial openness on carbon emission and ecological footprints in the long run increases by 0.5% and 0.09% respectively. The implication is that financial openness has significant impact on carbon emission and ecological footprints in the long run in ECOWAS region.

As regards the short-run coefficients, the parameters of lag one of KOF globalization index on carbon emission is positive and significant at 5% level while that of KOF globalization index on ecological footprints is negative and not significant this means the effects of KOF globalization index on carbon emission in the short run is statistically confirmed while that of KOF globalization index on ecological footprints in the short run is not statistically confirmed. However, in the long run the parameters of lag one of KOF globalization index on carbon emission and ecological footprint is negative and not statistically significant. It means that either a decrease or increase in KOF globalization index does not have any effect on carbon emission and ecological footprints in ECOWAS region.

Similarly, the indirect impacts of income growth, square of income growth and institutional quality on carbon emission and ecological footprints in the short run are statistically insignificant at 0.05 critical values. However, domestic credit to private sector on carbon emission are statistically significant at the conventional level while that of domestic credit to private sector on ecological footprints are statistically not significant at the conventional level. In the case of energy use on carbon emission and ecological footprints the coefficients were statistically insignificant in the short run except in the case of energy use and carbon emission with retrospect to trade openness which was significant at 1%. In the long run the coefficient of income growth on carbon emission and ecological footprints is statistically significant and positive which opposes the idea of Kuznets curve. The coefficient of income growth squared is statistically significant and negative which opposes the idea of Kuznets curve. The coefficient of domestic credit to private sector and energy use on carbon emission and

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ecological footprints is statistically significant at conventional level while that of institutional quality is statistically insignificant.

4.2.2 Analysis of the Second Objective

Concerning this sub-section, the research study presents the empirical outcomes relating to the effects of globalization on income inequality in ECOWAS.

4.2.2.1 Correlation Analysis and Scatter Plots

Table 4.8 presents the partial correlation coefficients of the variables relating to the relationship between globalization and income inequality in ECOWAS. The coefficient of correlation result shows that globalization indices (such as trade per capita, foreign direct investment, and KOF globalization index) has positive level of association with income inequality except in the case of trade per capita and income inequality where a negative relationship exists. A pictorial view of the correlation coefficients is depicted in the scatter graph of the variables in Figures 4.8 a-d. The scatter plot between trade per capita and income inequality as well as KOF globalization index and income inequality have a negative relationship as the graph slopes downwards, in the case of trade per capita and income inequality there exist a moderate negative association while that of KOF globalization index and income inequality have a weak negative relationship. Figure 4.8b depicts that the association between foreign direct investment and income inequality have a moderate positive relationship as there exist an upward trend movement in the graph. Figure 4.8d shows the moderate negative association that exist between GDP per capita and income inequality.

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Table 4.8: Correlation Matrix

	trdpc	fdi	kofgi	fd	inc	inf	pse	iq
gini	-0.236	0.2363	0.1593	-0.1981	-0.1422	0.1450	-0.0686	-0.2640
trdpc	1	0.0091	0.4223	0.8294	0.8943	-0.1192	0.3690	0.5657
fdi		1	0.0551	0.0299	0.0101	0.0702	0.2133	-0.0535
kofgi			1	0.4601	0.5712	0.0494	0.4545	0.3595
fd				1	0.7050	-0.2603	0.4159	0.6028
inc					1	-0.0996	0.3583	0.4609
inf						1	-0.0240	-0.1338
pse							1	0.0637

Note: gini- Income Inequality, trdpc - Trade per capita (current US$), fdi - Foreign direct investment, net inflows (% of GDP), kofgi – KOF Globalization Index, fd - Domestic credit to private sector by banks (% of GDP), inc - GDP per capita (current US$), inf - Inflation, consumer prices (annual %), pse - School enrolment, primary (% gross), iq - Institutional Quality.
Source: Author's computation 2022.

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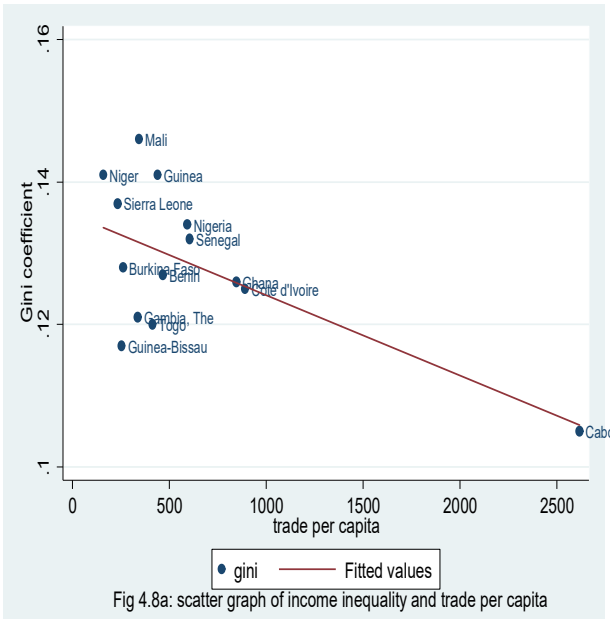

Fig 4.8a: scatter graph of income inequality and trade per capita

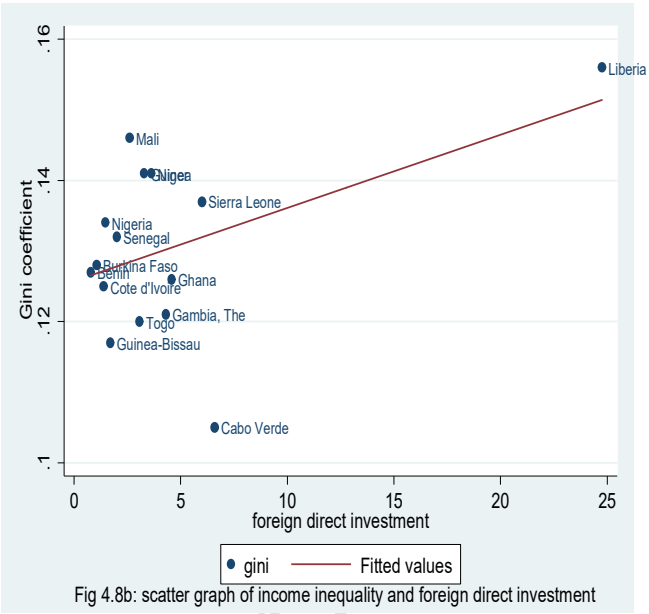

Fig 4.8b: scatter graph of income inequality and foreign direct investment

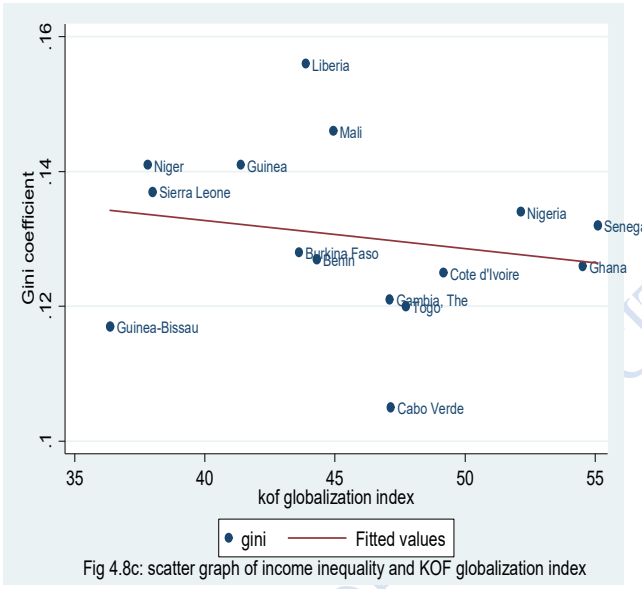

Fig 4.8c: scatter graph of income inequality and KOF globalization index

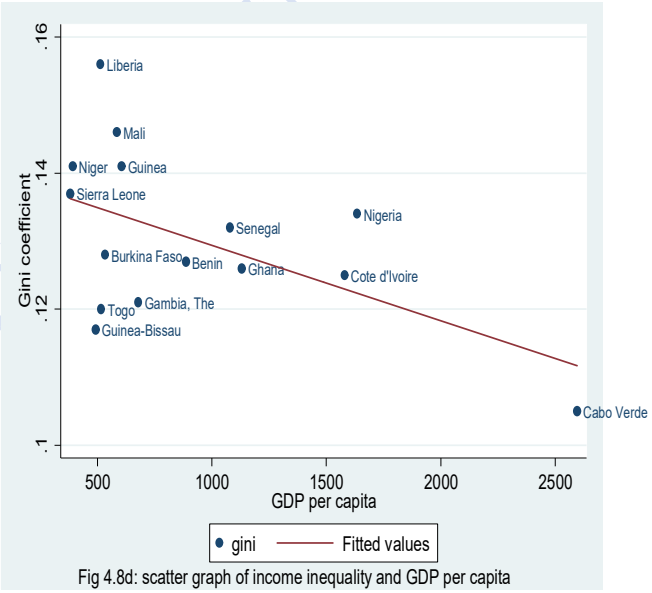

Fig 4.8d: scatter graph of income inequality and GDP per capita

Figure 4.8(a-d): Scatter Plots of Income Inequality and Globalization
Source: Author's computation 2022

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4.2.2.2 Cross-sectional Dependence, Stationary and Cointegration Tests

The results of cross-sectional dependence test are presented in Table 4.9. The test statistics were performed for fifteen West African countries (Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo), for a period of 24 years (1996–2019). The Breusch-Pagan LM test results presented in Table 4.9 confirm the rejection of null hypotheses of no correlation at conventional significance levels. Also, the Pesaran scaled LM test results are asymptotically standard normal and the statistical values strongly reject the null hypotheses at 5% significance level. As for the test statistic values of standard normal Pesaran CD test, their statistical values are significantly below the values of LM tests and they still reject the null hypotheses at 0.05 critical values.

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Table 4.9: Cross-sectional Dependence Test Results (d.f. = 105)

Hypothesis 2	**Statistics**	**Probability**
Gini Index		
Model 1: gini trdpc gs pse inf fd inc		
Breusch-Pagan LM	937.4330	0.0000
Pesaran scaled LM	62.74179	0.0000
Pesaran CD	2.766531	0.0057
Model 2: gini kofgi gs pse inf fd inc		
Breusch-Pagan LM	813.6817	0.0000
Pesaran scaled LM	53.56873	0.0000
Pesaran CD	0.853249	0.0335
Model 3: gini fdi gs pse inf fd inc		
Breusch-Pagan LM	910.7284	0.0000
Pesaran scaled LM	60.76231	0.0000
Pesaran CD	2.352205	0.0187

Note: gini - Income inequality; trdpc- trade per capita (current US$); kofgi – KOF Globalization Index; fdi - Foreign direct investment, net inflows (% of GDP); gs - General government final consumption expenditure per capita (current US$); pse – School enrollment, primary (% gross); inf - Inflation, consumer prices (annual %); fd - Domestic credit to private sector by banks (% of GDP); inc - GDP per capita (current US$).
Source: Author's computation 2022.

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4.2.2.3 Unit Root and Cointegration Tests

Furthermore, the panel unit root and cointegration tests were reported. Concerning Table 4.10, it shows the unit root test results using Levin, Lin and Chin (LLC), Breitung (Breit) and Im, Pesaran & Shin (IPS) statistics approaches. As reported in the table, the methods confirmed that among the three proxies for globalization, KOF globalization index (kofgi) and trade per capita (trdpc) are integrated at the first difference I(1) while foreign direct investment (fdi) is stationary at levels I(0). On the other hand, for income inequality (gini), the unit root result is mixed using the three estimators and was stationary at first difference I(1). Domestic credit to private sector (fd), and GDP per capita (inc), are all integrated at first difference I(1). Lastly inflation (inf) and primary school enrollment (pse) are stationary at levels I(0).

Table 4.11 presents the KAO Residual test for cointegration. Within the conventional probability test criteria, Table 4.10 revealed that a rejection of the null hypotheses of no cointegration for the three models at 5% level of significance. This means that there exists a long-run relationship among the regressand and regressors across all the estimated models in the study. Thus, it confirms the presence of co-integration or a long-run relationship between globalization and income inequality in ECOWAS.

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Table 4.10: Panel Unit Root Test Results

Signs	Variable Description	Levels			1st Difference			Decision
		LLC	Breit	IPS	LLC	Breit	IPS	
fd	Domestic credit to private sector by banks	-0.2556	0.7949	-0.9451	-10.491***	-3.5509***	-9.677***	I(1)
fdi	Foreign direct investment	-3.5095***	-4.0637***	-4.8123***	-	-	-	I(0)
inc	GDP per capita	1.2296	-1.1811	2.1404	-9.948***	-7.1586**	-8.432***	I(1)
inf	Inflation, consumer prices	-7.789***	-4.215***	-8.462***	-	-	-	I(0)
kofgi	KOF globalization index	-1.8275	0.598	-1.3729	-12.878***	-10.135**	-12.144***	I(1)
pse	School enrollment, primary	-67.424***	0.6089	-20.649***	-	-	-	I(0)
trdpc	Trade per capita	1.1745	-1.2746	0.8392	-10.493***	-6.6141***	-9.761***	I(1)
Gini	Income inequality	-2.0133**	2.2370	-0.4854	-	-1.8948**	-2.2114***	I(1)

Note: LL denotes Levin, Lin & Chin 2002; Breit represents Breitung 2001; IPS denotes Im, Pesaran & Shin 2003; ***, ** & * denote 1%, 5% & 10% significance levels.
Source: Author's computation 2022.

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Table 4.11: Kao Residual Test for Cointegration

Hypothesis 2	**Statistics**	**Probability**
Gini Index		
Model 1: gini trdpc pse inf fd inc	-1.7876	0.0369
ADF		
Residual variance	1.00E-05	
HAC variance	2.53E-05	
Model 2: gini kofgi pse inf fd inc	-1.6795	0.0465
ADF		
Residual variance	1.00E-05	
HAC variance	2.32E-05	
Model 3: gini fdi pse inf fd inc	-2.08697	0.0184
ADF		
Residual variance	9.97E-06	
HAC variance	2.60E-05	

Note: gini - Income inequality; trdpc- trade per capita (current US$); kofgi –KOF Globalization Index; fdi - Foreign direct investment, net inflows (% of GDP); pse – School enrollment, primary (% gross); inf - Inflation, consumer prices (annual %); fd - Domestic credit to private sector by banks (% of GDP); inc - GDP per capita (current US$).
Source: Author's computation 2022.

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4.2.2.4 Short Run and Long Run Parameter Estimates

The empirical result of the effects of globalization on income inequality in ECOWAS region using the pooled mean group estimator was discussed in this section. The null hypotheses of Hausman tests in Table 4.12, indicate that the difference in coefficients of mean group and pooled mean group not being systematic are not rejected at 5% level of significance. It therefore signifies the suitability of pooled mean group as the appropriate estimator to test the research hypothesis. Income inequality as the outcome variable was measured by Gini. Accordingly, three models were estimated, and they are labeled 1, 2, and 3. The selection of optimal lag lengths on the variables were selected automatically using the Bayesian Information Criterion (BIC) after setting it at three in order to ensure sufficient degree of freedom. The most common lag across the fifteen countries in ECOWAS is one for each variable of interest. Table 4.12 presents the summary of short-run and long-run parameter estimates of the pooled mean group or panel autoregressive distributed - ARDL (1, 1, 1, 1, 1, 1). From the table, the coefficients of error correction term are found to be negative and statistically significant at the conventional level. Specifically, the coefficients of the error correction term are -0.1067, -0.2462 and -0.0617, and the probability values of their t-statistic is less than 1%. It implies that the empirical models of globalization on income inequality correct their short-run disequilibrium by 10.7%, 24.6%, and 6.2% speed of adjustment in order to return to the long run equilibrium. This further confirms that there exists a long-run relationship between globalization and income inequality in ECOWAS region. Thus, it confirmed that the models' equilibrium nature is valid in the long run[1].

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Table 4.12: Pooled Mean Group Estimates of Globalization and Income Inequality

Variables	**Dependent Variable:** Income Inequality		
	1	2	3
Short-Run Estimates			
ECT	-0.1067***	-0.2462***	-0.0617***
	(0.0118)	(0.0173)	(0.0144)
D(trade openness(-1))	-0.00003	-	-
	(0.0019)	-	-
D(KOF globalization index(-1))	-	-0.0002	-
	-	(0.0001)	-
D(financial openness(-1))	-	-	0.00004
	-	-	(0.0001)
D(primary school enrolment(-1))	-0.000013*	-0.00001	-0.00001*
	(0.000008)	(0.00001)	(0.00001)
D(inflation(-1))	0.000035	-0.00006**	-0.00005***
	(0.000027)	(0.00003)	(0.00002)
D(domestic credit to private sector(-1))	0.00015	0.0002	0.0002
	(0.0002)	(0.0002)	(0.0002)
D(income growth(-1))	0.0019	0.00164	0.0026
	(0.0019)	(0.0018)	(0.0019)
Long-Run Estimates			
Trade openness	-0.1049***	-	-
	(0.0254)	-	-
KOF globalization index	-	-0.0055***	-
	-	(0.0009)	-
Financial openness	-	-	0.00126**
	-	-	(0.0006)
Primary school enrolment	0.00003	-0.00022***	-0.00017**
	(0.00007)	(0.00063)	(0.00008)
Inflation rate	-0.0011**	-0.00009	-0.0009**
	(0.0005)	(0.00048)	(0.0004)
Domestic credit to private sector by banks	-0.0069***	-0.0020***	-0.0069***
	(0.0014)	(0.00060)	(0.0014)
Income growth	0.1446***	0.0743***	-0.0226**
	(0.0335)	(0.0107)	(0.0097)
Constant	0.0013	-0.00024	0.0010
	(0.0014)	(0.0011)	(0.0048)
Log Likelihood	1651.77	1742.41	1739.55
Hausman Test (Prob.)	3.32(0.431)	6.88(0.230)	4.64(0.352)
Country	15	15	15
Observations	322	341	341

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.10.
Source: Author's computation 2022

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As regards the short-run coefficients, the parameters of lag one of trade openness on income inequality is negative and not significant at conventional level this means the effects of trade openness on income inequality in the short run is not statistically confirmed. However, in the long run the parameters of lag one of trade openness on income inequality is negative and statistically significant at 1% level. It means that there exists an inverse relationship between trade openness and income inequality in ECOWAS region. This further implies that an increase in trade openness will lead to a corresponding decrease in income inequality and this will give room for reduction in disparities of income. A 10% change in trade openness on income inequality in the long run decreases by 10.5%. The implication is that trade openness has significant impact on income inequality in the long run in ECOWAS region.

Concerning the short-run coefficients, the parameters of lag one of financial openness on income inequality is positive and not significant this means the effects of financial openness on income inequality in the short run is not statistically confirmed. However, in the long run the parameters of lag one of financial openness on income inequality is positive and statistically significant at 5% level. It implies that there exists a direct relationship between financial openness and income inequality in ECOWAS region. This further implies that an increase in financial openness will lead to a corresponding increase in income inequality and this will give room for greater disparities in income. A 10% change in financial openness on income inequality in the long run increases by 0.01%. The implication is that financial openness has significant impact on income inequality in the long run in ECOWAS region.

Regarding the short-run coefficients, the parameters of lag one of KOF globalization index on income inequality is negative and not significant this means the effects of KOF globalization index on income inequality in the short run is not statistically confirmed. However, in the long run the parameters of lag one of KOF globalization index on income inequality is negative and statistically significant at 1%. It implies that there exists an inverse relationship

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between KOF globalization index on income inequality in ECOWAS region. This further implies that an increase in KOF globalization index will lead to a corresponding decrease in income inequality and this will give room for reduction in disparities of income. A 100% change in KOF globalization index on income inequality in the long run decreases by 0.6%. The implication is that KOF globalization index has significant impact on income inequality in the long run in ECOWAS region.

Similarly, the indirect impacts of primary school enrolment and inflation in the short run was statistically significant at 10% and the latter at 0.05 critical value respectively. However, the coefficient of domestic credit to private sector and income growth on income inequality are positive and statistically not significant at the conventional level. In the long run the coefficient of primary school enrolment and inflation was statistically significant at 5%. The coefficient of domestic credit to private sector by banks and income growth on income inequality is statistically significant at 1%.

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4.2.3 Analysis of the Third Objective

Regarding this sub-section, the research study provides the empirical outcomes relating to the effects of environmental sustainability on income inequality in ECOWAS.

4.2.3.1 Correlation Analysis and Scatter Plots

Table 4.12 presents the partial correlation coefficients of the variables relating to the relationship between environmental sustainability and income inequality in ECOWAS. The coefficient of correlation result shows that carbon emission has a negative level of association with income inequality (-0.2138) while that of ecological footprints has positive level of association with income inequality (0.02032). A pictorial view of the correlation coefficients is depicted in the scatter graph of the variables in Figures 4.9 a-b. The scatter plot between carbon emission and income inequality as the graph slopes downwards while that of ecological footprints and income inequality shows a weak negative relationship as the graph slopes slightly downwards.

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Table 4.13: Correlation Matrix

	co2	ecft	fd	inc	inf	Pse	Iq
gini	-0.2138	0.02032	-0.1981	-0.14215	0.14502	-0.06862	-0.26397
co2	1	0.35477	0.68972	0.81237	0.00064	0.47783	0.48144
ecft		1	0.37692	0.39766	0.10396	0.037104	0.444914
fd			1	0.705036	-0.2603	0.41586	0.602798
inc				1	-0.0996	0.358274	0.460939
inf					1	-0.02399	-0.13376
pse						1	0.063711

Note: gini - Gini coefficient, CO_2 - Carbon emission (metric tons per capita), ecft- Ecological Footprint, fd- Domestic credit to private sector by banks (% of GDP), inc- GDP per capita (current US$), inf - inflation rate, pse - primary school education enrolment, iq- Institutional Quality.
Source: Author's computation 2022.

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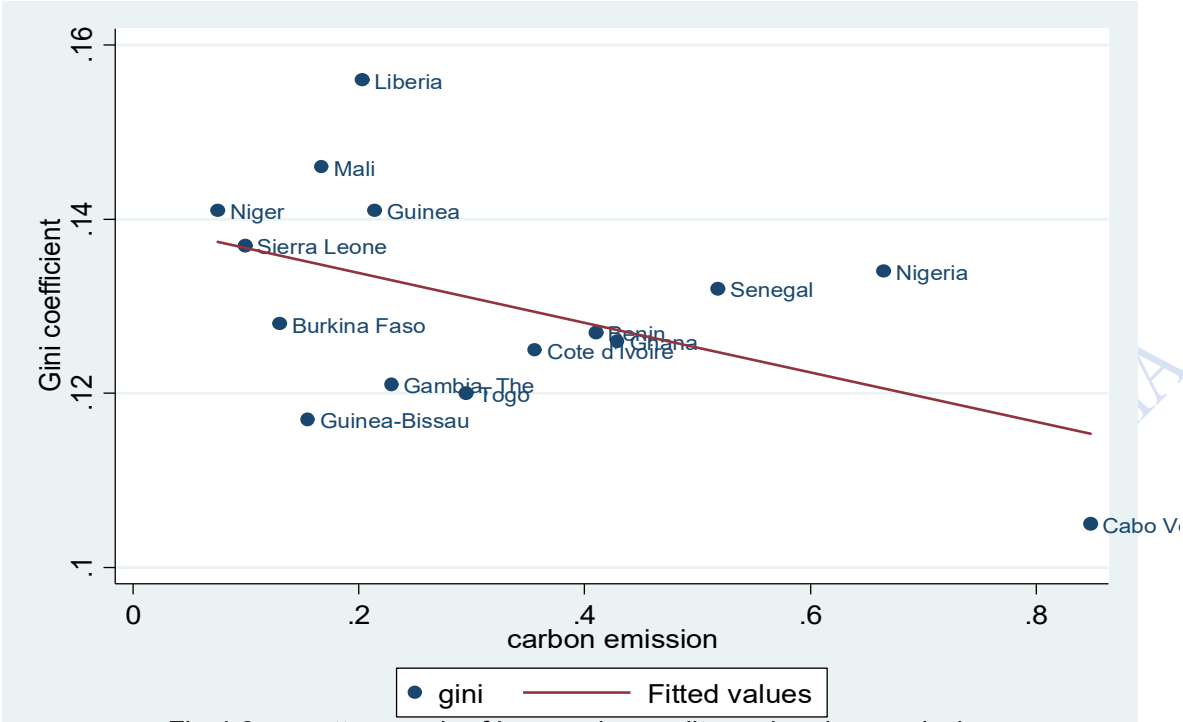

Fig 4.9a: scatter graph of income inequality and carbon emission

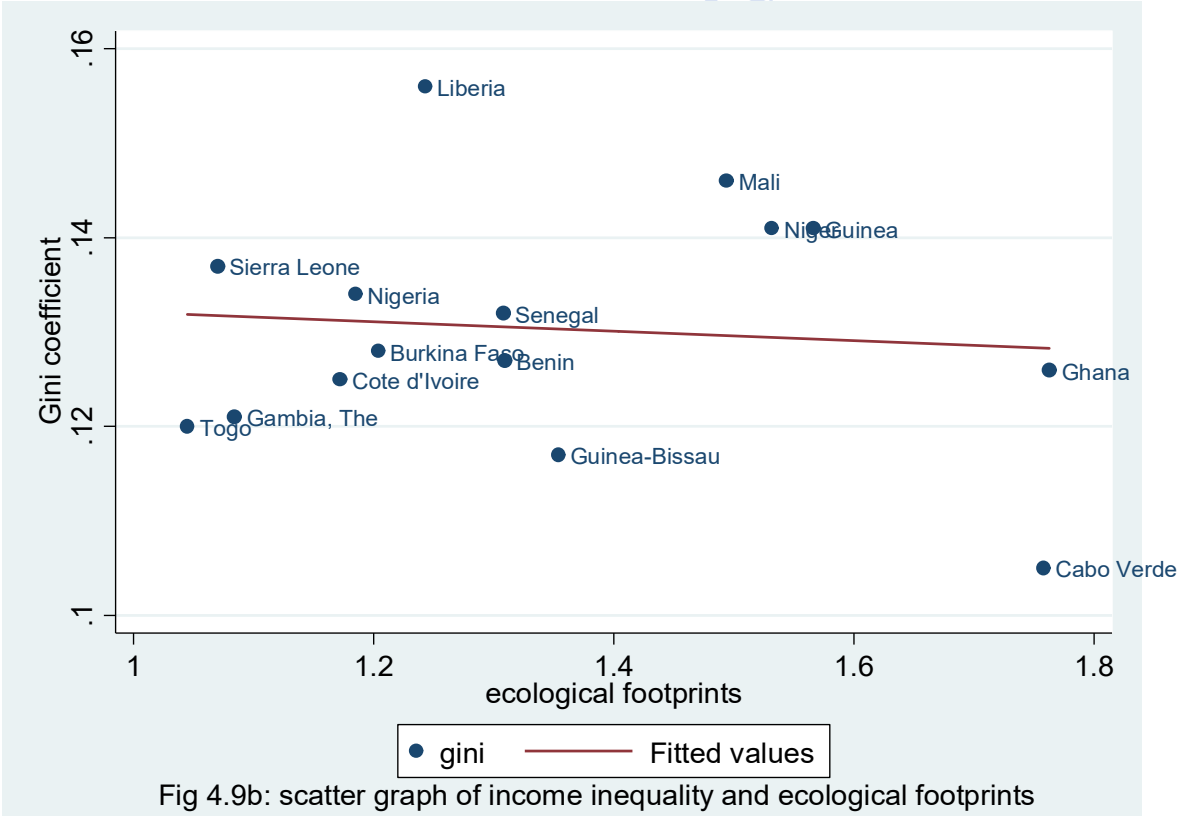

Fig 4.9b: scatter graph of income inequality and ecological footprints

Figure 4.9(a-b): Scatter Plots of Income Inequality and Environmental Sustainability

Source: Author's computation 2022

4.2.3.2 Cross-Sectional Dependence, Stationary and Cointegration Tests

The results of cross-sectional dependence test are presented in Table 4.14. The test statistics were performed for fifteen West African countries (Benin, Burkina Faso, Cabo Verde, Cote d'Ivoire, Gambia, Ghana, Guinea, Guinea-Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo), for a period of 24 years (1996–2019). The Breusch-Pagan LM test results presented in Table 4.14 confirm the rejection of null hypotheses of no correlation at conventional significance levels. Also, the Pesaran scaled LM test results are asymptotically standard normal and the statistical values strongly reject the null hypotheses at 5% significance level. As for the test statistic values of standard normal Pesaran CD test, their statistical values are significantly below the values of LM tests, and they still reject the null hypotheses at 0.05 critical values.

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Table 4.14: Cross-sectional Dependence Test Results (d.f. = 105)

Hypothesis 3	**Statistics**	**Probability**
Gini Index		
Model 1: gini co_2 inc pse inf fd		
Breusch-Pagan LM	909.6724	0.0000
Pesaran scaled LM	60.68404	0.0000
Pesaran CD	2.634466	0.0084
Model 2: gini ecft inc pse inf fd		
Breusch-Pagan LM	958.7840	0.0000
Pesaran scaled LM	64.32176	0.0000
Pesaran CD	2.959719	0.0031

Note: gini - Income inequality; co_2 - Carbon emission (metrics ton per capita); ecft - Ecological footprint; inc - GDP per capita (current US$); pse – School enrollment, primary (% gross); inf - Inflation, consumer prices (annual %); fd - Domestic credit to private sector by banks (% of GDP).
Source: Author's computation 2022.

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4.2.3.3 Unit Root and Cointegration Tests

Furthermore, the panel unit root and cointegration tests were reported. Concerning Table 4.15, it shows the unit root test results using Levin, Lin and Chin (LLC), Breitung (Breit) and Im, Pesaran & Shin (IPS) statistics approaches. As reported in the table, the methods confirmed that the two indices of environmental sustainability, carbon emission (CO_2) and ecological footprints (ecft) are stationary at the level of I(0). On the other hand, for income inequality (gini), the unit root result is mixed using the three estimators and was stationary at first difference I(1). Domestic credit to private sector (fd), GDP per capita (inc), are all integrated at first difference I(1). Lastly, inflation (inf) and primary school enrollment (pse) are stationary at levels I(0).

Table 4.16 presents the KAO Residual test for cointegration. Within the conventional probability test criteria, Table 4.16 revealed that a rejection of the null hypotheses of no cointegration for the two models at 5% level of significance. This means that there exists a long-run relationship among the regressand and regressors across all the estimated models in the study. Thus, it confirms that the presence of co-integration or a long-run relationship between environmental sustainability and income inequality in ECOWAS.

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Table 4.15: Panel Unit Root Test Results

Signs	Variable Description	Levels			1st Difference			Decision
		LLC	Breit	IPS	LLC	Breit	IPS	
co2	Carbon emission	-2.725***	-1.9829**	-4.378***	-	-	-	I(0)
ecft	Ecological Footprints	-4.617***	-3.191***	-5.1901***	-	-	-	I(0)
fd	Domestic credit to private sector by banks	-0.2556	0.7949	-0.9451	-10.491***	-3.5509***	-9.677***	I(1)
inc	GDP per capita	1.2296	-1.1811	2.1404	-9.948***	-7.1586**	-8.432***	I(1)
inf	Inflation, consumer prices	-7.789***	-4.215***	-8.462***	-	-	-	I(0)
pse	School enrollment, primary	-67.424***	0.6089	-20.649***	-	-	-	I(0)
Gini	Income inequality	-2.01330**	2.23702	-0.48538	-	-1.8948**	-2.2114***	I(1)

Note: LL denotes Levin, Lin & Chin 2002; Breit represents Breitung 2001; IPS denotes Im, Pesaran & Shin 2003; ***, ** & * denote 1%, 5% & 10% significance levels.
Source: Author's computation 2022.

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Table 4.16: KAO Residual Test for Cointegration

Hypothesis 3	**Statistics**	**Probability**
Gini Index		
Model 1: gini co_2 inc pse inf fd	-1.7753	0.0379
ADF		
Residual variance	9.73E-06	
HAC variance	2.46E-05	
Model 2: gini ecft inc pse inf fd	-1.7867	0.0370
ADF		
Residual variance	1.00E-05	
HAC variance	2.53E-05	

Note: gini - Income inequality; co_2–Carbon emission (metrics ton per capita); ecft - Ecological footprint; inc - GDP per capita (current US$);pse – School enrollment, primary (% gross); inf - Inflation, consumer prices (annual %); fd - Domestic credit to private sector by banks (% of GDP).
Source: Author's computation 2022.

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4.2.3.4 Short Run and Long Run Parameter Estimates

The empirical result of the effects of environmental sustainability on income inequality in ECOWAS region using the pooled mean group estimator was discussed in this section. The null hypotheses of Hausman tests in Table 4.17, indicate that the difference in coefficients of mean group and pooled mean group not being systematic are not rejected at 5% level of significance. It therefore signifies the suitability of pooled mean group as the appropriate estimator to test the research hypothesis. Income inequality as the outcome variable was measured by Gini. Accordingly, two models were estimated, and they are labeled 1, and 2. The selection of optimal lag lengths on the variables were selected automatically using the Bayesian Information Criterion (BIC) after setting it at three in order to ensure sufficient degree of freedom. The most common lag across the fifteen countries in ECOWAS is one for each variable of interest. Table 4.17 presents the summary of short-run and long-run parameter estimates of the pooled mean group or panel autoregressive distributed - ARDL (1, 1, 1, 1, 1, 1). From the table, the coefficients of error correction term are found to be negative and statistically significant at the conventional level. Specifically, the coefficients of the error correction term are -0.042, and -0.2911, and the probability values of their t-statistic is less than 1%. It implies that the empirical models of environmental sustainability on income inequality correct their short-run disequilibrium by 4.2%, and 29.1% speed of adjustment in order to return to the long run equilibrium. This further confirms that there exists a long-run relationship between environmental sustainability and income inequality in ECOWAS region. Thus, it confirmed that the models' equilibrium nature is valid in the long run[1].

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Table 4.17: Pooled Mean Group Estimates of Environmental Sustainability and Income Inequality

Variables	**Dependent Variable:** Income inequality	
	1	2
Short-Run Estimates		
ECT	-0.042***	-0.2911****
	(0.0173)	(0.1616)
D(carbon emission (-1))	0.0016	-
	(0.0018)	-
D(ecological footprints(-1))	-	0.0036
	-	(0.0023)
D(income growth (-1))	0.0014	0.0031*
	(0.0016)	(0.0018)
D((primary school enrollment (-1))	-0.0000	0.0000
	(0.0000)	(0.0000)
D(inflation (-1))	-0.0000	-0.0000***
	(0.0000)	(0.0000)
D(financial openness(-1))	0.0001	-0.0001
	(0.0002)	(0.0002)
Long-Run Estimates		
Carbon emission	-0.0575***	-
	(0.0097)	-
Ecological footprints	-	-0.1516***
	-	(0.0252)
Income growth	0.0197***	0.0257***
	(0.0049)	(0.0055)
Primary school enrollment	-0.0001***	-0.0001**
	(0.0000)	(0.0000)
Inflation	-0.0007***	-0.0004
	(0.0003)	(0.0003)
Financial openness	0.0016***	0.0005
	(0.0003)	(0.0005)
Constant	-0.0029*	0.0008
	(0.0016)	(0.0007)
Log Likelihood	1728.4	1720.77
Hausman Test (Prob.)	1.32(0.933)	0.88(0.927)
Country	15	15
Observations	337	341

Note: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.10.
Source: Author's computation (2021).

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As regards the short-run coefficients, the parameters of lag one of carbon emission on income inequality is positive and not significant at conventional level this means the effects of carbon emission on income inequality in the short run is not statistically confirmed. However, in the long run the parameters of lag one of carbon emission on income inequality is negative and statistically significant at 1% level. It means that there exists an inverse relationship between carbon emission and income inequality in ECOWAS region. A 10% change in carbon emission on income inequality in the long run increases by 0.6%. The implication is that carbon emission has significant impact on income inequality in the long run in ECOWAS region.

With reference to the short-run coefficients, the parameters of lag one of ecological footprints on income inequality is positive and not significant this means the effects of ecological footprints on income inequality in the short run is not statistically confirmed. However, in the long run the parameters of lag one of ecological footprints on income inequality is negative and statistically significant at 1% level. It means that there exists a negative relationship between ecological footprints and income inequality in ECOWAS region. A 10% change in ecological footprints on income inequality in the long run increases by 1.52%. The implication is that ecological footprints have significant impact on income inequality in the long run in ECOWAS region.

Similarly, the indirect impacts of primary school enrolment and financial openness in the short run were not statistically significant at conventional level. However, the coefficient of income growth on income inequality with retrospect to carbon emission is positive and not statistically significant while with retrospect to ecological footprint the coefficient is positive and statistically significant at 10%, similarly, the coefficient for inflation on income inequality with retrospect to carbon emission is negative and statistically not significant while with retrospect to ecological footprint the coefficient is negative and significant at 1%. In the

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long run the coefficient of income growth and primary school enrolment was statistically significant at conventional levels. The coefficient of inflation on income inequality with retrospect to carbon emission is negative and statistically significant at 1% while with retrospect to ecological footprints the coefficient is negative and not statistically significant. The coefficient of financial openness on income inequality with retrospect to carbon emission is positive and statistically significant at 1% while with retrospect to ecological footprints the coefficient is positive and not statistically significant.

4.3 Discussion of Findings

4.3.1 Effect of Globalization on Environmental Sustainability in ECOWAS

The findings show that trade openness, and financial openness has a positive and significant impact on carbon emission and ecological footprint used as measurements of environmental sustainability in ECOWAS. This falls within the theoretical expectations of existing studies and theories which state that globalization can either be positive or negative depending on how the country handles it. With respect to ECOWAS, from the findings globalization has a positive impact on carbon emission and ecological footprints, this implies that any increase in trade openness or financial openness will activate a corresponding decrease in environmental sustainability. This could be because of the foreign direct investments as well as foreign technologies coming into the receiving country being non-environmentally friendly, thus, further polluting the environment. The research outcome is consistent with the results of a study conducted on the effects of globalization on environmental degradation within the periods of 1971 and 2018 in Nigeria using the quantile-quantile approach, which argued that globalization significantly and positively impact the deterioration of environment[2]. Likewise, it aligns with the research outcomes on globalization, and co_2emission between the period 1991 to 2019 in One Belt One Road (OBOR) and South Asian region, using advanced and robust econometric strategies (second generation), which argued that there exists a significant

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positive relationship between globalization and co_2 emission[3]. A research study also affirmed a positive and significant link between globalization and carbon emissions in Pakistan using the ARDL approach with data ranging from 1975 to 2015[4].Likewise, it aligns with the research outcomes on globalization on environmental pollution using data from 38 countries in Sub-Sahara Africa from the period 1980 to 2017, using the second-generation panel data test, which argued that globalization along with its de jure and de facto aspects, contributes positively to environmental pollution in SSA by increasing carbon dioxide (co_2) emissions[5].

4.3.2 Effect of Globalization on Income Inequality in ECOWAS

The findings show that trade openness and KOF globalization index has a negative and significant impact on Gini used as a measurement for income inequality in ECOWAS. This falls within the theoretical expectations of existing studies and theories which states that globalization is expected to reduce income inequality. An improvement in trade openness and KOF globalization index will further close the widening gaps of disparities in income in ECOWAS. The research outcome is consistent with the results of a study conducted on trade openness and income, using a data set of 139 different countries, they employed an approach known as the instrumental variable (IV) and discovered that trade openness in emerging and developing world tends to decrease income inequality[6]. Likewise, it aligns with the research outcomes on the effects of trade on income inequality within the periods of 1980 and 2008using balanced panel consisting of 11 countries in Sub-Sahara Africa, using fractional regression models for panel data as their method of estimation, and discovered that trade lowers income inequality[7].

4.3.3 Effect of Environmental Sustainability on Income Inequality in ECOWAS

The findings show that carbon emission and ecological footprint has a negative and significant impact on Gini coefficient used as a measurement for income inequality in

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ECOWAS. This does not fall within the theoretical expectations which states that environmental sustainability will reduce income inequality. This could imply that the environmental sustainability programme practiced by countries in the ECOWAS region has failed to curtail income inequality. The research outcome is not consistent with the results of a study conducted on climate change and wealth inequality, they made use of panel data for 138 nations between 1955 and 2019, they also used standard panel regression analysis and a panel vector autoregression model, their results revealed that rising economic inequality is positively correlated with climate change vulnerability[8]. Likewise, it does not align with the research outcomes on whether changes in income inequality has an impact on carbon dioxide emission in OECD nations, using developed panel data estimation technique it was reported that increase in top income inequality is positively associated with co_2 emissions[9]. Similarly, it does not align with the research outcomes on the key factors influencing the short- and long-term patterns of co_2 emissions because of changes in growth and income inequality for 11 Mediterranean economies from 1990 to 2012, using autoregressive dynamic distributive lag it was discovered that there exist a direct and significant link between carbon emissions and income disparity as well as a positive significant correlation between co_2 emissions and income inequality in the short term[10].

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Endnotes

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Chapter Five

Conclusion

This chapter presents the summary, conclusion, and recommendation of the study. This is divided into five sections which includes summary of findings, conclusion, recommendations, contribution to knowledge, and suggestions for future studies.

5.1 Summary of Findings

The broad objective of this study was to examine the relationship among globalization, environmental sustainability, and income inequality in ECOWAS using an annual data from 1996 to 2019. The estimator employed was the pooled mean group estimation technique. The empirical results of specific objectives are reported and discussed in the previous chapter in details. However, the summary findings from this study are discussed in this sub-section.

The result of the trend analysis did not present a precise or exact relationship among globalization, environmental sustainability, and income inequality in ECOWAS whether it is direct or indirect. It however, necessitated the need for empirical analysis with more appropriate econometrics tools as the directions of the variables are inconclusive. The unit root results revealed that some of the series are not stationary at levels but after differencing once, they were stationary. This implies that many of these series trended with prevalent economic, political, financial, social, institutions, trade, and external sector reforms. Therefore, they have stochastic trends. The long-run co-movement of the variables was confirmed using Kao residual test for cointegration. The parameter estimates were estimated using pooled mean group based on the result of the Hausman test.

For the first objective, trade openness at first lag positively influences carbon emission in the short run but not significant at 5% level of significance. Also, trade openness on ecological footprints at lag one has a negative and not significant result in the short run. However, in the

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long run trade openness at lag one positively and significantly impact carbon emission and ecological footprints at 1% level of significance. Also, financial openness on carbon emission at lag one in the short run has a negative and insignificant effect at 5% level of significance. Also, financial openness on ecological footprints at lag one in the short run is negative but significant at 10% level of significance. However, in the long run financial openness at lag one has a positive and significant impact on carbon emission and ecological footprints at 1% level of significance. Also, KOF globalization index at lag one in the short run has a positive and significant effect on carbon emission at 5% level of significance while that of KOF globalization index at lag one in the short run has a negative and insignificant effect on ecological footprints at conventional levels. However, in the long run KOF globalization index has a negative and insignificant impact on carbon emission and ecological footprints at conventional levels.

For the second objective, trade openness at first lag negatively influences income inequality in the short run and not significant at 5% level of significance. However, in the long run trade openness at lag one negatively and significantly impact income inequality at 1% level of significance. Also, financial openness on income inequality at lag one in the short run has a positive and insignificant effect at 5% level of significance. However, in the long run financial openness at lag one has a positive and significant impact on income inequality at 5% level of significance. Also, KOF globalization index at lag one in the short run has a negative and insignificant effect on income inequality at 5% level of significance. However, in the long run KOF globalization index has a negative and significant impact on income inequality at 1% level of significance.

For the third objective, carbon emission at first lag positively influences income inequality in the short run and not significant at 5% level of significance. However, in the long run carbon emission at lag one negatively and significantly impact income inequality at 1% level of

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significance. Also, ecological footprints on income inequality at lag one in the short run has a positive and insignificant effect at 5% level of significance. However, in the long run ecological footprints at lag one has a negative and statistically significant impact on income inequality at 1% level of significance

5.2 Conclusion

This study provides an empirical insight on the links among globalization, environmental sustainability, and income inequality in ECOWAS for a period of 1996 and 2019. The problem of environmental sustainability has been one of the major challenges impeding globalization and income inequality in ECOWAS region. Thus, the issue on ground is not just to ensure sustainable environment for future generation amidst of other economic goals, but to adopt appropriate policies that are able to combat environmental degradation over the coming years as they serve as catalyst towards ensuring income equality in ECOWAS.

The study formulated three specific objectives and evaluated using appropriate statistical methods like pooled mean group approaches, whereas pre-estimation tests (such as charts, descriptive statistics, correlation matrix, scatter plots, cross sectional dependence, panel unit root and Kao cointegration) were carried out to validate the choice of our estimation techniques.

The empirical findings show that two of the indices for globalization i.e., trade openness and financial openness positively and significantly impact environmental sustainability in the long run in ECOWAS region for the period. This implies that the trading activities carried out by countries in ECOWAS with the rest of the world is responsible for poor environmental sustainability, this therefore, implies that trade globalization contribute to poor environmental quality. As regards financial globalization, it was concluded that the type of foreign direct investments coming into the country further pollutes the environment this aligns with the

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Pollution Haven Hypothesis which states that globalization further deteriorate the environment especially in developing countries which have less stringent environmental policy as opposed to developed countries with strict environmental policy. As regards KOF globalization index which signifies overall globalization, it was concluded that in the long run KOF globalization index has a negative and insignificant effect on environmental sustainability this implies that either increase or decrease in KOF globalization index does not have any impact on environmental sustainability in ECOWAS.

As regards globalization and income inequality, the empirical findings shows that the three indices of globalization i.e., trade openness, financial openness and KOF globalization index significantly impact income inequality in the long run in ECOWAS region for the time periods. With respect to trade globalization and KOF globalization index, it was concluded that there exists a negative and significant effect on income inequality, this implies that the type of trading activities that countries in ECOWAS region engage in with the rest of the world is beneficial and important in reducing inequalities of income in ECOWAS region. Likewise, the KOF globalization index depicts that an increase in KOF globalization index in ECOWAS will further reduce income inequality. As for financial globalization it was concluded that it has a positive and significant impact on income inequality, this implies that the type of foreign direct investments coming into the country further expand the disparity in the distribution of income.

The empirical findings show that two of the indices for environmental sustainability i.e., carbon emission and ecological footprints negatively and significantly impact income inequality in the long run in ECOWAS region for the time periods. This implies that increase in carbon emission and ecological footprints in ECOWAS is responsible for reducing disparities in income distribution.

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5.3 Recommendations

The following recommendations arising from the empirical results of this study are suggested in this sub-section. The following suggestions are stated as follows:

i. The study reported that globalization has a negative impact on environmental sustainability i.e., foreign direct investment further deteriorates the environment in ECOWAS region. It suggests that government should enforce environmental laws and regulations that prevent multinationals firm from using non-renewable energy sources in production activities in ECOWAS region.

ii. Based on the findings that globalization has a negative impact on environmental sustainability i.e., openness to trade further deteriorates the environment in ECOWAS region. It is highly recommended that policies that can ease quick transitioning away from trading activities that contribute to carbon emission by indigenous and foreign firms should be put in place.

iii. In addition, cautious action is also needed by the financial industry for foreign direct investment in order to achieve a desirable level of income equality. This was based on the findings that foreign direct investment played a positive and significant impact on income inequality in ECOWAS.

iv. Concerning the fact that trade openness and KOF globalization index are also important globalization variables that determine income inequality in ECOWAS region, it is however, suggested that government should put in place incentives and policies to further encourage production and trading activities among countries in ECOWAS region with the rest of the world.

v. Also, the countries carbon emission and ecological footprint issues show the importance of monitoring and controlling the activities geared towards sustainable

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environment as these have tendency of improving the income distribution disparities in ECOWAS region. The government and policy makers should ensure that strict policies to promote healthy environment are enacted which in turn will ensure income sustainability and equality.

5.4 Contribution to Knowledge

The contributions made by this study to the existing literature are in the areas of identified gaps and achieved with the proposition of appropriate policy suggestions based on the results obtained from empirical findings. The following major contributions are stated below as:

Empirical Policy Analysis: This study contributed to the existing body of literature by filling the empirical gaps in literature by investigating the impact of globalization, environmental sustainability, and income inequality. The study found that trade globalization and KOF globalization index can improve the disparities of incomes in the long run. Also, financial globalization if not properly monitored could serve as a triggering factor for income inequality in the long run. Apart from this, the study also confirms sustainability of the environment as a key factor in increasing the gaps in income disparities between the rich and the poor. The findings also provide testable hypotheses for future studies regarding how the globalization variables (trade openness, financial openness, and KOF globalization index) influence environmental sustainability and income inequality in ECOWAS region.

Methodological Analysis: This study employs appropriate estimation techniques to achieve the stated objectives. The study used pooled mean group estimation technique to examine both the short- and long- run estimates of the parameters of our variables. These estimation approaches have explicitly shown the interrelationship among globalization, environmental sustainability, and income inequality in short-run and long-run.

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5.5 Suggestion for Further Studies

Future studies can conduct a structural break analysis of the variables which will provide chances of comparing different policy eras or major events that are prominent in the ECOWAS economy. In addition, the adoption of non-linear estimation approaches such as the quantile approach to establish the links among globalization, environmental sustainability and income inequality would expand frontiers of knowledge. More economic policy variables like fiscal policy (government spending) among others can be included in the income inequality model for more future knowledge expansion.

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Appendix

Descriptive statistics

Sign	Variable Measurements	Mean	Standard Deviation	Maximum	Minimum	Kurtosis	Skewness	Obs.
gini	Income Inequality	0.130	0.019	0.169	0.084	-0.528	-0.085	360
co_2	CO_2 emissions (metric tons per capita)	0.320	0.238	1.182	0	1.848	1.416	358
ecft	Ecological Footprint	1.339	0.261	2.218	0.895	0.356	0.868	360
trdpc	Trade per capita (current US$)	563.9	695.3	4229.5	0	11.182	3.159	360
fdi	Foreign direct investment, net inflows (% of GDP)	4.251	9.687	103.3	-2.545	61.467	7.329	356
kofgi	KOFGlobalization Index	45.544	7.414	61.634	25.622	-0.231	-0.179	360
fd	Domestic credit to private sector by banks (% of GDP)	14.226	11.921	65.278	0	6.068	2.260	353
eu	Energy intensity level of primary energy (MJ/$2017 PPP GDP)	6.377	3.068	15.820	2.6	0.328	1.053	300
inc	GDP per capita (current US$)	911.1	745.644	3740.4	138.7	3.551	1.907	356
gs	General government final consumption expenditure per capita(current US$)	106.9	119.366	701.6	4.273	12.049	3.360	306
inf	Inflation, consumer prices (annual %)	5.869	7.800	50.734	-3.503	10.264	2.717	333
pse	School enrollment, primary (% gross)	87.523	23.242	143.7	28.008	-0.369	-0.136	295
iq	Institutional Quality	-0.671	0.448	0.377	-1.870	-0.240	0.240	360

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Average of Globalization, Environmental Sustainability, and Income Inequality (1996-2019)

S/N	Country	gini	co2	ecft	trdpc	fdi	kofgi	inc	gs	iq
1	Benin	0.127	0.410	1.309	466.84	0.788	44.30	886.30	91.61	-0.468
2	Burkina Faso	0.128	0.130	1.204	260.94	1.049	43.62	533.08	85.70	-0.370
3	Cabo Verde	0.105	0.848	1.758	2616.71	6.587	47.15	2595.31	615.95	0.258
4	Cote d'Ivoire	0.125	0.356	1.172	891.63	1.389	49.17	1580.23	209.03	-0.736
5	Gambia, The	0.121	0.229	1.084	337.31	4.307	47.11	678.40	62.79	-0.545
6	Ghana	0.126	0.429	1.763	845.52	4.574	54.53	1130.69	100.80	-0.121
7	Guinea	0.141	0.214	1.566	439.30	3.284	41.38	605.39	74.22	-0.984
8	Guinea-Bissau	0.117	0.155	1.354	254.16	1.701	36.36	491.69	55.67	-1.225
9	Liberia	0.156	0.203	1.243		24.749	43.88	513.27		-1.272
10	Mali	0.146	0.167	1.494	343.46	2.600	44.93	584.51	90.58	-0.664
11	Niger	0.141	0.075	1.532	159.22	3.622	37.80	391.51	66.54	-0.727
12	Nigeria	0.134	0.665	1.185	592.55	1.465	52.14	1634.72	102.37	-1.021
13	Senegal	0.132	0.518	1.308	605.66	2.009	55.10	1078.79	146.48	-0.207
14	Sierra Leone	0.137	0.099	1.070	232.71	5.996	37.99	380.72	38.15	-1.039
15	Togo	0.120	0.295	1.045	412.73	3.065	47.72	516.01	70.30	-0.938

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Correlation Matrix

	gini	*co2*	*ecft*	*trdpc*	*fdi*	*kofgi*	*fd*	*eu*	*inc*	*inc²*	*gs*	*inf*	*pse*	*iq*
gini	1													
co2	-0.21377	1												
ecft	0.020318	0.35477	1											
trdpc	-0.23623	0.791698	0.516672	1										
fdi	0.236257	-0.01035	0.057174	0.009066	1									
kofgi	0.159301	0.59296	0.167353	0.422251	0.055128	1								
fd	-0.1981	0.689721	0.376915	0.829403	0.029907	0.460075	1							
eu	0.143531	-0.34005	-0.34077	-0.44686	0.266085	-0.43057	-0.35774	1						
inc	-0.14215	0.812373	0.397664	0.894285	0.010114	0.571234	0.705036	-0.42464	1					
inc^2	-0.15285	0.769705	0.407109	0.918487	0.022101	0.410149	0.727684	-0.35829	0.953724	1				
gs	-0.0503	0.730281	0.485267	0.962466	0.250046	0.408038	0.87589	-0.40406	0.888468	0.925331	1			
inf	0.14502	0.000644	0.103959	-0.11924	0.070217	0.049356	-0.26026	0.119303	-0.09958	-0.0754	-0.18206	1		
pse	-0.06862	0.477834	0.037104	0.368956	0.213263	0.454487	0.41586	0.208099	0.358274	0.283158	0.29458	-0.02399	1	
iq	-0.26397	0.48144	0.444914	0.565743	-0.05348	0.359532	0.602798	-0.74403	0.460939	0.441933	0.563704	-0.13376	0.063711	1

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Pooled Mean Group
Objective 1
Notes:

1. Unicode is supported; see help unicode_advice.
2. Maximum number of variables is set to 5000; see help set_maxvar.

. *(17 variables, 360 observations pasted into data editor)

. xtsetc_id year
panel variable: c_id (strongly balanced)
time variable: year, 1996 to 2019
delta: 1 unit

. xtpmg d.co2 d.inc d.inc2 d.trdpcd.fd d.iq d.eu, lr(l.co2 inc inc2 trdpcfdiqeu) ec(ECT) replace mg

---

Mean Group Estimation: Error Correction Form
(Estimate results saved as mg)

D.co2	Coef.	Std. Err.	z	P>|z|	[95% Conf. Interval]
ECT					
inc	-5.646901	4.179028	-1.35	0.177	-13.83764 2.543843
inc2	.3486488	.2700472	1.29	0.197	-.180634 .8779317
trdpc	.9464446	.5021144	1.88	0.059	-.0376815 1.930571
fd	-.0048414	.0145458	-0.33	0.739	-.0333507 .0236679
iq	-.6612734	.7910102	-0.84	0.403	-2.211625 .889078
eu	.6490718	.3411986	1.90	0.057	-.0196652 1.317809
SR					
ECT	-.6153864	.0903494	-6.81	0.000	-.792468 -.4383047
inc					
D1.	.4185739	.859663	0.49	0.626	-1.266335 2.103482
inc2					
D1.	-.0400102	.0675023	-0.59	0.553	-.1723123 .0922919
trdpc					

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```
       D1. |  -.0204145   .0881407    -0.23   0.817     -.193167     .152338
           |
fd |
       D1. |   .0039069    .006061     0.64   0.519    -.0079725    .0157862
           |
iq |
       D1. |   .1024053   .0791335     1.29   0.196    -.0526936    .2575042
           |
eu |
       D1. |   .3737036   .1724501     2.17   0.030     .0357076    .7116997
           |
     _cons |   3.216456   7.119639     0.45   0.651    -10.73778    17.17069
------------------------------------------------------------------------------

.
. xtpmg d.co2 d.inc d.inc2 d.trdpcd.fd d.iq d.eu, lr(l.co2 inc inc2 trdpcfdiqeu) ec(ECT) replace
pmg

Iteration 0:   log likelihood =  394.61401  (not concave)
Iteration 1:   log likelihood =  400.52235  (not concave)
Iteration 2:   log likelihood =     403.03  (not concave)
Iteration 3:   log likelihood =  405.67759  (not concave)
Iteration 4:   log likelihood =  407.29608  (not concave)
Iteration 5:   log likelihood =   409.7033
Iteration 6:   log likelihood =   409.9454
Iteration 7:   log likelihood =  410.67927
Iteration 8:   log likelihood =  410.74273
Iteration 9:   log likelihood =  410.74286
Iteration 10:  log likelihood =  410.74286

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): c_id                Number of obs      =       321
Time Variable (t): year                 Number of groups   =        14
Obs per group: min =        22
                                        avg =      22.9
                                        max =        23

                                    Log Likelihood     =  410.7429
```

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```
------------------------------------------------------------------------------
     D.co2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
inc|  -2.135783   .6512011    -3.28   0.001    -3.412113    -.859452
      inc2 |    .142577   .0455698     3.13   0.002     .0532618    .2318923
trdpc |   .7328281   .1083997     6.76   0.000     .5203685    .9452876
fd |   .0212907   .0052184     4.08   0.000     .0110628    .0315186
iq |   .0274687   .1680906     0.16   0.870    -.3019829    .3569203
eu |   .3213067   .1515398     2.12   0.034     .0242942    .6183191
-------------+----------------------------------------------------------------
SR           |
       ECT |   -.28744   .0795304    -3.61   0.000    -.4433166   -.1315634
           |
inc |
       D1. |   .5238142   1.429697     0.37   0.714    -2.278341    3.32597
           |
      inc2 |
       D1. |  -.0586958   .1064326    -0.55   0.581    -.2672999    .1499082
           |
trdpc |
       D1. |   .0204755   .0931107     0.22   0.826    -.1620181    .2029691
           |
fd |
       D1. |  -.0077474   .0033461    -2.32   0.021    -.0143057   -.0011891
           |
iq |
       D1. |   .0646181   .0857279     0.75   0.451    -.1034055    .2326417
           |
eu |
       D1. |   .6308681   .2278214     2.77   0.006     .1843463     1.07739
           |
     _cons |   .3199516   .0739298     4.33   0.000     .1750518    .4648514
------------------------------------------------------------------------------

.
. hausman mg pmg, sigmamore

                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
```

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```
             |      mg         pmg        Difference         S.E.
-------------+------------------------------------------------------------------
inc |   -5.646901    -2.135783       -3.511118        7.978146
       inc2 |    .3486488      .142577        .2060718        .5152481
trdpc |    .9464446     .7328281        .2136166        .9556419
fd |   -.0048414     .0212907       -.0261321        .0273686
iq |   -.6612734     .0274687       -.6887422         1.50578
eu |    .6490718     .3213067        .3277652        .6357339
------------------------------------------------------------------------------
                    b = consistent under Ho and Ha; obtained from xtpmg
         B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

    Test:  Ho:  difference in coefficients not systematic

                chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                        =        4.45
              Prob>chi2 =      0.6156


.
.
.
. xtpmg d.co2 d.inc d.inc2 d.fdid.fd d.iq d.eu, lr(l.co2 inc inc2 fdifdiqeu) ec(ECT) replace mg

------------------------------------------------------------------------------
Mean Group Estimation: Error Correction Form
(Estimate results saved as mg)
------------------------------------------------------------------------------
------------------------------------------------------------------------------
      D.co2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
inc|  -34.51192   35.28888    -0.98   0.328    -103.6769    34.65301
       inc2 |   2.868162   2.852591     1.01   0.315    -2.722814    8.459138
fdi|  -.1591012   .1512032    -1.05   0.293    -.4554539    .1372516
fd|  -.1105141   .1141354    -0.97   0.333    -.3342154    .1131871
iq |   4.185727   4.352949     0.96   0.336    -4.345897    12.71735
eu|  -.0723192   .5237057    -0.14   0.890    -1.098764    .9541251
-------------+----------------------------------------------------------------
SR           |
        ECT |  -.6605746   .1031836    -6.40   0.000    -.8628107   -.4583384
```

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```
             |
inc |
       D1. |   2.165829    1.25583     1.72   0.085    -.295553     4.62721
             |
      inc2 |
       D1. |  -.1685442   .0986004    -1.71   0.087    -.3617975    .0247091
             |
fdi |
       D1. |  -.0041534   .0049267    -0.84   0.399    -.0138096    .0055028
             |
fd |
       D1. |   .0059934   .0053189     1.13   0.260    -.0044315    .0164182
             |
iq |
       D1. |   .2545458   .1622547     1.57   0.117    -.0634676    .5725593
             |
eu |
       D1. |   .6118153   .2771989     2.21   0.027     .0685155    1.155115
             |
     _cons |   5.647583    7.10338     0.80   0.427    -8.274786    19.56995
------------------------------------------------------------------------------

.
. xtpmg d.co2 d.inc d.inc2 d.fdid.fd d.iq d.eu, lr(l.co2 inc inc2 fdifdiqeu) ec(ECT) replace pmg

Iteration 0:   log likelihood =  393.27504  (not concave)
Iteration 1:   log likelihood =  395.56266  (not concave)
Iteration 2:   log likelihood =  411.47386  (not concave)
Iteration 3:   log likelihood =  416.86721
Iteration 4:   log likelihood =  421.41621  (not concave)
Iteration 5:   log likelihood =  430.04778
Iteration 6:   log likelihood =  437.05796
Iteration 7:   log likelihood =  440.72084  (not concave)
Iteration 8:   log likelihood =  442.70048
Iteration 9:   log likelihood =   445.4004
Iteration 10:  log likelihood =  445.78309
Iteration 11:  log likelihood =   445.7966
Iteration 12:  log likelihood =   445.7966

Pooled Mean Group Regression
```

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(Estimate results saved as pmg)

Panel Variable (i): c_id Number of obs = 339
Time Variable (t): year Number of groups = 15
Obs per group: min = 18
avg = 22.6
max = 23

Log Likelihood = 445.7966

D.co2	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ECT						
inc	-4.101266	1.060143	-3.87	0.000	-6.179109	-2.023424
inc2	.3478003	.0870259	4.00	0.000	.1772326	.518368
fdi	.0502602	.0064023	7.85	0.000	.0377119	.0628086
fd	.0384461	.0035522	10.82	0.000	.0314838	.0454083
iq	-.2739952	.1839538	-1.49	0.136	-.634538	.0865476
eu	-.3784534	.1648785	-2.30	0.022	-.7016093	-.0552974
SR						
ECT	-.1900282	.072049	-2.64	0.008	-.3312418	-.0488147
inc						
D1.	2.481205	1.961091	1.27	0.206	-1.362463	6.324873
inc2						
D1.	-.2153165	.1592341	-1.35	0.176	-.5274097	.0967766
fdi						
D1.	-.0057135	.0037201	-1.54	0.125	-.0130047	.0015776
fd						
D1.	-.0115316	.0037623	-3.07	0.002	-.0189055	-.0041577
iq						
D1.	.0500761	.0788062	0.64	0.525	-.1043812	.2045334
eu						
D1.	.7985165	.2281673	3.50	0.000	.3513169	1.245716

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```
           |
      _cons |   1.916883   .7016621     2.73   0.006     .5416507    3.292116
------------------------------------------------------------------------------

.
. hausman mg pmg, sigmamore

                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       mg          pmg         Difference          S.E.
-------------+----------------------------------------------------------------
         inc |   -34.51192    -4.101266      -30.41066        70.88207
        inc2 |    2.868162     .3478003       2.520362        5.729762
         fdi |   -.1591012     .0502602      -.2093614        .3036767
          fd |   -.1105141     .0384461      -.1489602        .2292531
          iq |    4.185727    -.2739952       4.459722        8.742479
          eu |   -.0723192    -.3784534       .3061342        1.039045
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtpmg
            B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        4.08
                Prob>chi2 =      0.6287

.
.
.
. xtpmg d.co2 d.inc d.inc2 d.kofgid.fd d.iq d.eu, lr(l.co2 inc inc2 kofgifdiqeu) ec(ECT) replace
mg

------------------------------------------------------------------------------
Mean Group Estimation: Error Correction Form
(Estimate results saved as mg)
------------------------------------------------------------------------------
------------------------------------------------------------------------------
      D.co2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

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```
ECT          |
inc|  -4.805526   3.649309    -1.32   0.188    -11.95804    2.346988
      inc2 |   .4370194   .2875845     1.52   0.129    -.1266359    1.000675
kofgi |    .017169   .0115045     1.49   0.136    -.0053793    .0397173
fd|  -.0002638   .0078833    -0.03   0.973    -.0157149    .0151872
iq|  -.2549508    .223254    -1.14   0.253    -.6925206    .1826189
eu |   .6997469   .3257002     2.15   0.032     .0613862    1.338108
-------------+----------------------------------------------------------------
SR           |
       ECT |  -.8012941   .1065555    -7.52   0.000    -1.010139    -.592449
           |
inc |
       D1. |   1.300223   1.139227     1.14   0.254    -.9326213    3.533068
           |
      inc2 |
       D1. |  -.1109785   .0893858    -1.24   0.214    -.2861713    .0642144
           |
kofgi |
       D1. |   .0099755   .0193361     0.52   0.606    -.0279226    .0478736
           |
fd |
       D1. |   .0025375   .0045295     0.56   0.575    -.0063402    .0114152
           |
iq |
       D1. |   .2635813    .170543     1.55   0.122    -.0706769    .5978394
           |
eu |
       D1. |   .2220426    .219885     1.01   0.313    -.2089241    .6530093
           |
     _cons |   14.19657   10.35215     1.37   0.170    -6.093272    34.48642
------------------------------------------------------------------------------
```

```
.
. xtpmg d.co2 d.inc d.inc2 d.kofgid.fd d.iq d.eu, lr(l.co2 inc inc2 kofgifdiqeu) ec(ECT) replace
pmg

Iteration 0:   log likelihood =  402.08275
Iteration 1:   log likelihood =   403.3248  (not concave)
Iteration 2:   log likelihood =  409.39524  (not concave)
Iteration 3:   log likelihood =  413.69305
```

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Iteration 4: log likelihood = 415.44676 (not concave)
Iteration 5: log likelihood = 417.5089 (not concave)
Iteration 6: log likelihood = 418.05293 (not concave)
Iteration 7: log likelihood = 418.17685 (not concave)
Iteration 8: log likelihood = 418.195 (not concave)
Iteration 9: log likelihood = 418.20341 (not concave)
Iteration 10: log likelihood = 418.21229 (not concave)
Iteration 11: log likelihood = 418.2159 (not concave)
Iteration 12: log likelihood = 418.2184 (not concave)
Iteration 13: log likelihood = 418.22086 (not concave)
Iteration 14: log likelihood = 418.2366 (not concave)
Iteration 15: log likelihood = 418.25144 (not concave)
Iteration 16: log likelihood = 418.25392 (not concave)
Iteration 17: log likelihood = 418.25645 (not concave)
Iteration 18: log likelihood = 418.27254 (not concave)
Iteration 19: log likelihood = 418.28783 (not concave)
Iteration 20: log likelihood = 418.29045 (not concave)
Iteration 21: log likelihood = 418.29304 (not concave)
Iteration 22: log likelihood = 418.30103 (not concave)
Iteration 23: log likelihood = 418.30894 (not concave)
Iteration 24: log likelihood = 418.31189 (not concave)
Iteration 25: log likelihood = 418.31488 (not concave)
Iteration 26: log likelihood = 418.37645 (not concave)
Iteration 27: log likelihood = 418.46582
Iteration 28: log likelihood = 420.76278 (backed up)
Iteration 29: log likelihood = 422.00397
Iteration 30: log likelihood = 422.06033
Iteration 31: log likelihood = 422.06038
Iteration 32: log likelihood = 422.06038

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): c_id Number of obs = 339
Time Variable (t): year Number of groups = 15
Obs per group: min = 18
avg = 22.6
max = 23

Log Likelihood = 422.0604

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```
------------------------------------------------------------------------------
     D.co2 |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
inc|  -7.831072   1.474653    -5.31   0.000    -10.72134   -4.940805
      inc2 |   .6675447   .1189974     5.61   0.000     .434314    .9007754
kofgi|  -.0093429   .0123719    -0.76   0.450    -.0335915    .0149056
fd |   .0360399    .005956     6.05   0.000     .0243663    .0477136
iq |    .155382    .170042     0.91   0.361    -.1778942    .4886581
eu|  -1.089719   .1745993    -6.24   0.000    -1.431928   -.7475111
-------------+----------------------------------------------------------------
SR           |
       ECT |  -.1731794   .0735428    -2.35   0.019    -.3173206   -.0290382
           |
inc |
       D1. |   1.562521   1.331893     1.17   0.241    -1.047941    4.172983
           |
      inc2 |
       D1. |  -.1297578   .1014967    -1.28   0.201    -.3286876    .0691721
           |
kofgi |
       D1. |    .01608    .007111     2.26   0.024     .0021426    .0300173
           |
fd |
       D1. |  -.0073924   .0033026    -2.24   0.025    -.0138653   -.0009195
           |
iq |
       D1. |   .0556455   .0724966     0.77   0.443    -.0864453    .1977362
           |
eu |
       D1. |   .8076489   .2139934     3.77   0.000     .3882296    1.227068
           |
     _cons |   4.030254   1.675277     2.41   0.016     .7467723    7.313736
------------------------------------------------------------------------------

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. hausman mg pmg, sigmamore

                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
```

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```
             |      mg         pmg        Difference         S.E.
-------------+------------------------------------------------------------
inc |   -4.805526    -7.831072        3.025546        9.063142
       inc2 |    .4370194     .6675447       -.2305253        .7137637
kofgi |     .017169    -.0093429        .0265119        .0261703
fd |   -.0002638     .0360399       -.0363038        .0189206
iq |   -.2549508      .155382       -.4103328        .5353936
eu |    .6997469    -1.089719        1.789466        .8007061
------------------------------------------------------------------------------
                    b = consistent under Ho and Ha; obtained from xtpmg
         B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

   Test:  Ho:  difference in coefficients not systematic

                chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                        =        4.96
              Prob>chi2 =      0.6028

.
.
.
. xtpmgd.ecft d.inc d.inc2 d.trdpcd.fd d.iq d.eu, lr(l.ecftinc inc2 trdpcfdiqeu) ec(ECT) replace mg

------------------------------------------------------------------------------
Mean Group Estimation: Error Correction Form
(Estimate results saved as mg)
------------------------------------------------------------------------------
------------------------------------------------------------------------------
D.ecft |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
inc|  -2.998965   1.590163    -1.89   0.059    -6.115628     .117698
       inc2 |   .2380997   .1277435     1.86   0.062     -.012273    .4884724
trdpc |   .0572037   .1341307     0.43   0.670    -.2056876     .320095
fd |   -.001702   .0047656    -0.36   0.721    -.0110424    .0076385
iq|  -.0845169   .0875605    -0.97   0.334    -.2561324    .0870985
eu |   .1490446   .1898233     0.79   0.432    -.2230022    .5210913
-------------+----------------------------------------------------------------
SR           |
         ECT |  -.9668812    .084816   -11.40   0.000    -1.133117   -.8006449
```

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```
             |
inc |
       D1. |   2.842665   2.240822     1.27   0.205    -1.549265    7.234596
             |
      inc2 |
       D1. |  -.2223875    .165693    -1.34   0.180    -.5471398    .1023648
             |
trdpc |
       D1. |  -.0671134   .0429707    -1.56   0.118    -.1513345    .0171076
             |
fd |
       D1. |   .0041025   .0037292     1.10   0.271    -.0032065    .0114115
             |
iq |
       D1. |   .0914031   .0964036     0.95   0.343    -.0975446    .2803508
             |
eu |
       D1. |    .102158   .1379254     0.74   0.459    -.1681708    .3724868
             |
     _cons |   10.50799   6.206934     1.69   0.090    -1.657375    22.67336
------------------------------------------------------------------------------

.
. xtpmgd.ecft d.inc d.inc2 d.trdpcd.fd d.iq d.eu, lr(l.ecftinc inc2 trdpcfdiqeu) ec(ECT) replace
pmg

Iteration 0:   log likelihood =  539.86004  (not concave)
Iteration 1:   log likelihood =  541.95408  (not concave)
Iteration 2:   log likelihood =   544.2784  (not concave)
Iteration 3:   log likelihood =  546.05605  (not concave)
Iteration 4:   log likelihood =  546.40302  (not concave)
Iteration 5:   log likelihood =  546.70932  (not concave)
Iteration 6:   log likelihood =  546.93817  (not concave)
Iteration 7:   log likelihood =  547.16706  (not concave)
Iteration 8:   log likelihood =  547.37328  (not concave)
Iteration 9:   log likelihood =  547.59643  (not concave)
Iteration 10:  log likelihood =  547.89191  (not concave)
Iteration 11:  log likelihood =  548.22622  (not concave)
Iteration 12:  log likelihood =   548.7208
Iteration 13:  log likelihood =  551.21184
```

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```
Iteration 14:  log likelihood =   552.0584
Iteration 15:  log likelihood =  552.07837
Iteration 16:  log likelihood =  552.07838

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): c_id                Number of obs      =       322
Time Variable (t): year                 Number of groups   =        14
Obs per group: min =        23
                                        avg =      23.0
                                        max =        23

                                Log Likelihood     =  552.0784
------------------------------------------------------------------------------
D.ecft |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
inc|  -.5211609   .1703537    -3.06   0.002    -.8550479   -.1872738
       inc2 |   .0441041   .0120315     3.67   0.000     .0205228    .0676854
trdpc |   .1054292   .0327786     3.22   0.001     .0411842    .1696741
fd|  -.0036035   .0013389    -2.69   0.007    -.0062278   -.0009793
iq |   .0917824    .059157     1.55   0.121    -.0241632     .207728
eu |    .140772   .0497924     2.83   0.005     .0431807    .2383632
-------------+----------------------------------------------------------------
SR           |
        ECT |  -.5264708   .0997148    -5.28   0.000    -.7219084   -.3310333
            |
inc |
        D1. |  -.2664424   .8796054    -0.30   0.762    -1.990437    1.457553
            |
       inc2 |
        D1. |   .0219032   .0655921     0.33   0.738    -.1066549    .1504613
            |
trdpc |
        D1. |   -.092498   .0562882    -1.64   0.100    -.2028209    .0178249
            |
fd |
        D1. |   .0031463   .0021898     1.44   0.151    -.0011456    .0074382
            |
```

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```
iq |
       D1. |  -.0019841   .0420777    -0.05   0.962    -.0844549    .0804867
           |
eu |
       D1. |  -.0169069   .0990845    -0.17   0.865    -.2111089     .177295
           |
     _cons |   .5603941   .1140241     4.91   0.000     .3369109    .7838772
------------------------------------------------------------------------------

.
. hausman mg pmg, sigmamore

                ---- Coefficients ----
             |      (b)          (B)          (b-B)     sqrt(diag(V_b-V_B))
             |       mg          pmg        Difference          S.E.
-------------+----------------------------------------------------------------
inc |   -2.998965    -.5211609       -2.477804        3.675831
       inc2 |    .2380997     .0441041        .1939956        .2953646
trdpc |    .0572037     .1054292       -.0482254        .3086544
fd |    -.001702    -.0036035        .0019016        .0109465
iq |   -.0845169     .0917824       -.1762993        .1937947
eu |    .1490446      .140772        .0082726        .4364363
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtpmg
            B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        5.24
                Prob>chi2 =      0.5130

.
.
.
. xtpmgd.ecft d.inc d.inc2 d.fdid.fd d.iq d.eu, lr(l.ecftinc inc2 fdifdiqeu) ec(ECT) replace mg

------------------------------------------------------------------------------
Mean Group Estimation: Error Correction Form
(Estimate results saved as mg)
```

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```
------------------------------------------------------------------------------
------------------------------------------------------------------------------
D.ecft |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
inc|  -4.834752   1.475951    -3.28   0.001    -7.727562   -1.941942
      inc2 |   .3766068   .1120964     3.36   0.001     .1569018    .5963118
fdi |   .0098119   .0079516     1.23   0.217     -.005773    .0253968
fd|  -.0010921   .0063385    -0.17   0.863    -.0135152     .011331
iq|  -.0187803   .1008998    -0.19   0.852    -.2165402    .1789797
eu|  -.1082294    .162079    -0.67   0.504    -.4258984    .2094396
-------------+----------------------------------------------------------------
SR           |
       ECT |  -.9416749   .1073974    -8.77   0.000     -1.15217   -.7311798
           |
inc |
       D1. |   3.395381   1.371871     2.48   0.013     .7065636    6.084199
           |
      inc2 |
       D1. |   -.263773   .1045365    -2.52   0.012    -.4686606   -.0588853
           |
fdi |
       D1. |  -.0048383   .0053067    -0.91   0.362    -.0152393    .0055628
           |
fd |
       D1. |   .0056066   .0037512     1.49   0.135    -.0017457    .0129589
           |
iq |
       D1. |    .027931   .0665066     0.42   0.675    -.1024194    .1582815
           |
eu |
       D1. |   .1437391   .1535242     0.94   0.349    -.1571628     .444641
           |
     _cons |   16.68823   6.437018     2.59   0.010     4.071905    29.30455
------------------------------------------------------------------------------

.
. xtpmgd.ecft d.inc d.inc2 d.fdid.fd d.iq d.eu, lr(l.ecftinc inc2 fdifdiqeu) ec(ECT) replace pmg

Iteration 0:   log likelihood =  577.55123  (not concave)
```

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```
Iteration 1:   log likelihood =  589.43149  (not concave)
Iteration 2:   log likelihood =  593.43775
Iteration 3:   log likelihood =  596.46041
Iteration 4:   log likelihood =  596.63517
Iteration 5:   log likelihood =  596.63635
Iteration 6:   log likelihood =  596.63635

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): c_id                Number of obs      =       340
Time Variable (t): year                 Number of groups   =        15
Obs per group: min =         18
                                        avg =      22.7
                                        max =        23

                                Log Likelihood     =  596.6364
------------------------------------------------------------------------------
D.ecft |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
inc|  -.2556868   .1268145    -2.02   0.044    -.5042387   -.0071348
       inc2 |   .0301644   .0100205     3.01   0.003     .0105246    .0498042
fdi |   .0085298   .0024975     3.42   0.001     .0036349    .0134248
fd |   -.001364   .0011448    -1.19   0.233    -.0036077    .0008798
iq|  -.0361037   .0616655    -0.59   0.558    -.1569659    .0847585
eu |   .1153218   .0494652     2.33   0.020     .0183718    .2122719
-------------+----------------------------------------------------------------
SR           |
       ECT |    -.47559   .1037572    -4.58   0.000    -.6789504   -.2722296
           |
inc |
       D1. |   .4259306    .670911     0.63   0.526    -.8890308    1.740892
           |
      inc2 |
       D1. |  -.0361746   .0509444    -0.71   0.478    -.1360238    .0636746
           |
fdi |
       D1. |  -.0060366    .003437    -1.76   0.079    -.0127729    .0006997
           |
```

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```
fd |
       D1. |   .0027627   .0017966     1.54   0.124    -.0007585    .0062839
           |
iq |
       D1. |   .0385104   .0423676     0.91   0.363    -.0445286    .1215494
           |
eu |
       D1. |  -.0363117   .0926379    -0.39   0.695    -.2178786    .1452552
           |
     _cons |   .2311163   .0614117     3.76   0.000     .1107516     .351481
------------------------------------------------------------------------------

.
. hausman mg pmg, sigmamore

                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       mg          pmg         Difference          S.E.
-------------+----------------------------------------------------------------
inc |   -4.834752    -.2556868       -4.579066       3.159559
       inc2 |    .3766068     .0301644        .3464424        .2399483
fdi |    .0098119     .0085298        .0012821        .0168516
fd |   -.0010921     -.001364        .0002719        .0135313
iq |   -.0187803    -.0361037        .0173234        .2071874
eu |   -.1082294     .1153218       -.2235512        .3436997
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtpmg
            B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        3.95
                Prob>chi2 =      0.6829

.
.
.
. xtpmgd.ecft d.inc d.inc2 d.kofgid.fd d.iq d.eu, lr(l.ecftinc inc2 kofgifdiqeu) ec(ECT) replace mg
```

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```
------------------------------------------------------------------------------
Mean Group Estimation: Error Correction Form
(Estimate results saved as mg)
------------------------------------------------------------------------------
------------------------------------------------------------------------------
D.ecft |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
inc|  -3.465892   1.885097    -1.84   0.066    -7.160615    .2288306
      inc2 |   .2823759   .1459374     1.93   0.053    -.0036561    .5684079
kofgi |   .0019195    .004396     0.44   0.662    -.0066965    .0105354
fd |   .0003829   .0037126     0.10   0.918    -.0068937    .0076595
iq|  -.0777641   .0878712    -0.88   0.376    -.2499884    .0944602
eu |   .0197671   .1703461     0.12   0.908    -.3141052    .3536394
-------------+----------------------------------------------------------------
SR           |
       ECT |  -1.105184   .0811932   -13.61   0.000    -1.26432   -.9460482
           |
inc |
       D1. |   2.501046   1.790595     1.40   0.162   -1.008456    6.010548
           |
      inc2 |
       D1. |  -.1996297   .1329588    -1.50   0.133    -.4602241    .0609647
           |
kofgi |
       D1. |  -.0070131   .0047117    -1.49   0.137    -.0162478    .0022216
           |
fd |
       D1. |  -.0005734   .0037961    -0.15   0.880    -.0080137     .006867
           |
iq |
       D1. |   .0378391    .069551     0.54   0.586    -.0984784    .1741566
           |
eu |
       D1. |    .103201    .119917     0.86   0.389    -.131832    .3382339
           |
     _cons |   8.106253   4.744929     1.71   0.088   -1.193637    17.40614
------------------------------------------------------------------------------

.
```

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. xtpmgd.ecft d.inc d.inc2 d.kofgid.fd d.iq d.eu, lr(l.ecftinc inc2 kofgifdiqeu) ec(ECT) replace pmg

Iteration 0: log likelihood = 565.8638 (not concave)
Iteration 1: log likelihood = 578.34725 (not concave)
Iteration 2: log likelihood = 578.58898
Iteration 3: log likelihood = 583.11923
Iteration 4: log likelihood = 585.12628
Iteration 5: log likelihood = 589.26992 (not concave)
Iteration 6: log likelihood = 589.77611 (not concave)
Iteration 7: log likelihood = 589.87379 (not concave)
Iteration 8: log likelihood = 591.58464 (not concave)
Iteration 9: log likelihood = 592.95447
Iteration 10: log likelihood = 593.76659
Iteration 11: log likelihood = 593.91973
Iteration 12: log likelihood = 593.92053
Iteration 13: log likelihood = 593.92053

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): c_id Number of obs = 340
Time Variable (t): year Number of groups = 15
Obs per group: min = 18
avg = 22.7
max = 23

Log Likelihood = 593.9205

D.ecft	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ECT						
inc	-.2045423	.1705867	-1.20	0.231	-.5388861	.1298014
inc2	.026413	.0130039	2.03	0.042	.0009259	.0519001
kofgi	-.0001436	.0022921	-0.06	0.950	-.004636	.0043489
fd	-.0013694	.001388	-0.99	0.324	-.0040899	.0013511
iq	-.1204037	.0269894	-4.46	0.000	-.173302	-.0675054
eu	.0099667	.0356937	0.28	0.780	-.0599915	.079925
SR						

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```
         ECT |  -.5257111   .1109474    -4.74   0.000    -.7431641   -.3082582
             |
inc |
         D1. |   -.141469   .8402984    -0.17   0.866    -1.788424    1.505486
             |
        inc2 |
         D1. |   .0083323   .0619271     0.13   0.893    -.1130425    .1297071
             |
kofgi |
         D1. |  -.0004666   .0039528    -0.12   0.906     -.008214    .0072807
             |
fd |
         D1. |   .0020082   .0024154     0.83   0.406    -.0027258    .0067423
             |
iq |
         D1. |   .0333658   .0449565     0.74   0.458    -.0547473    .1214788
             |
eu |
         D1. |   .0623549   .1072295     0.58   0.561    -.1478111    .2725208
             |
       _cons |   .2394033   .0584423     4.10   0.000     .1248586    .3539481
------------------------------------------------------------------------------

.
. hausman mg pmg, sigmamore

                ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |       mg          pmg         Difference          S.E.
-------------+----------------------------------------------------------------
inc |   -3.465892    -.2045423       -3.26135        4.671007
       inc2 |    .2823759      .026413       .2559629       .3616197
kofgi |    .0019195    -.0001436        .002063       .0106562
fd |    .0003829    -.0013694       .0017523       .0091002
iq |   -.0777641    -.1204037       .0426396       .2161995
eu |    .0197671     .0099667       .0098004       .4208643
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtpmg
            B = inconsistent under Ha, efficient under Ho; obtained from xtpmg
```

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Test: Ho: difference in coefficients not systematic

chi2(6) = (b-B)'[(V_b-V_B)^(-1)](b-B)
= 2.22
Prob>chi2 = 0.8988

Objective 2

. xtpmgd.ginid.trdpcd.pse d.inf d.fd d.inc, lr(l.ginitrdpcpse inf fdinc) ec(ECT) replace pmg

Iteration 0: log likelihood = 1620.7601 (not concave)
Iteration 1: log likelihood = 1638.3508
Iteration 2: log likelihood = 1643.7011
Iteration 3: log likelihood = 1646.3944
Iteration 4: log likelihood = 1650.3501
Iteration 5: log likelihood = 1651.6139
Iteration 6: log likelihood = 1651.7669
Iteration 7: log likelihood = 1651.7684
Iteration 8: log likelihood = 1651.7684

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): c_id Number of obs = 322
Time Variable (t): year Number of groups = 14
Obs per group: min = 23
avg = 23.0
max = 23

Log Likelihood = 1651.768

D.gini	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ECT						
trdpc	-.1048497	.0254143	-4.13	0.000	-.1546609	-.0550385
pse	.0000323	.0000701	0.46	0.644	-.000105	.0001697
inf	-.0010596	.0004994	-2.12	0.034	-.0020385	-.0000807
fd	-.006893	.0013708	-5.03	0.000	-.0095797	-.0042063
inc	.1446039	.0335306	4.31	0.000	.0788851	.2103226

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```
SR          |
       ECT |  -.1067011   .0117854    -9.05   0.000    -.2320561    .0229922
           |
trdpc |
       D1. |   .0000292   .0018693     0.02   0.988    -.0036347     .003693
           |
pse |
       D1. |  -.0000131   7.66e-06    -1.71   0.087    -.0000281    1.89e-06
           |
       inf |
       D1. |  -.0000345   .0000271    -1.27   0.203    -.0000875    .0000186
           |
fd |
       D1. |   .0001477   .0002229     0.66   0.507    -.0002891    .0005845
           |
inc |
       D1. |   .0018925   .0018774     1.01   0.313    -.0017872    .0055723
           |
     _cons |   .0012563   .0013684     0.92   0.359    -.0014257    .0039383
------------------------------------------------------------------------------


. hausman mg pmg, sigmamore
estimation result mg not found
r(111);


.
.
.
. xtpmgd.ginid.kofgid.pse d.inf d.fd d.inc, lr(l.ginikofgipse inf fdinc) ec(ECT) replace mg

------------------------------------------------------------------------------
Mean Group Estimation: Error Correction Form
(Estimate results saved as mg)
------------------------------------------------------------------------------
------------------------------------------------------------------------------
D.gini |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
kofgi|  -.0110072   .0122702    -0.90   0.370    -.0350564    .0130419
```

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```
pse |  -.000155   .0007537    -0.21   0.837    -.0016321    .0013221
       inf |  .0052142   .0059256     0.88   0.379    -.0063998    .0168283
fd |  .0530624   .0573595     0.93   0.355    -.0593601    .1654848
inc|  -.4082359   .4368311    -0.93   0.350    -1.264409    .4479374
-------------+----------------------------------------------------------------
SR           |
       ECT |  -.1818838   .0499156    -3.64   0.000    -.2797166    -.084051
           |
kofgi |
       D1. |  -.0001594    .000207    -0.77   0.441    -.0005651    .0002463
           |
pse |
       D1. |   9.46e-06   .0000186     0.51   0.611     -.000027    .0000459
           |
       inf |
       D1. |   -.000021   .0000582    -0.36   0.719    -.0001351    .0000932
           |
fd |
       D1. |    .000198   .0001297     1.53   0.127    -.0000561    .0004521
           |
inc |
       D1. |  -.0014999   .0018457    -0.81   0.416    -.0051174    .0021175
           |
      _cons |   .0089908   .0127645     0.70   0.481    -.0160272    .0340089
------------------------------------------------------------------------------
```

```
.
. xtpmgd.ginid.kofgid.pse d.inf d.fd d.inc, lr(l.ginikofgipse inf fdinc) ec(ECT) replace pmg

Iteration 0:   log likelihood =  1713.7423  (not concave)
Iteration 1:   log likelihood =   1723.757  (not concave)
Iteration 2:   log likelihood =  1728.4384
Iteration 3:   log likelihood =  1733.5264  (not concave)
Iteration 4:   log likelihood =   1737.873
Iteration 5:   log likelihood =  1742.0923
Iteration 6:   log likelihood =  1742.4088
Iteration 7:   log likelihood =  1742.4106
Iteration 8:   log likelihood =  1742.4106

Pooled Mean Group Regression
```

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(Estimate results saved as pmg)

Panel Variable (i): c_id Number of obs = 341
Time Variable (t): year Number of groups = 15
Obs per group: min = 19
avg = 22.7
max = 23

Log Likelihood = 1742.411

D.gini	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ECT						
kofgi	-.0054844	.0009938	-5.52	0.000	-.0074323	-.0035365
pse	-.0002224	.0000633	-3.52	0.000	-.0003464	-.0000984
inf	-.0000848	.0004839	-0.18	0.861	-.0010332	.0008637
fd	-.0020213	.0006039	-3.35	0.001	-.0032049	-.0008377
inc	.074296	.0106494	6.98	0.000	.0534236	.0951685
SR						
ECT	-.2461681	.0172955	-14.21	0.000	-.5851541	.0092819
kofgi						
D1.	-.0002132	.0001305	-1.63	0.102	-.0004689	.0000425
pse						
D1.	-7.96e-06	9.37e-06	-0.85	0.396	-.0000263	.0000104
inf						
D1.	-.0000617	.0000271	-2.28	0.023	-.0001148	-8.59e-06
fd						
D1.	.0002214	.0001775	1.25	0.212	-.0001265	.0005694
inc						
D1.	.0016389	.001839	0.89	0.373	-.0019656	.0052434
_cons	-.0002399	.001091	-0.22	0.826	-.0023782	.0018985

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.
. hausman mg pmg, sigmamore

```
                ---- Coefficients ----
             |      (b)          (B)          (b-B)     sqrt(diag(V_b-V_B))
             |       mg          pmg         Difference          S.E.
-------------+----------------------------------------------------------------
kofgi |   -.0110072    -.0054844       -.0055228        .0282532
pse |    -.000155    -.0002224        .0000674        .0017353
        inf |    .0052142    -.0000848         .005299        .0136441
fd |    .0530624    -.0020213        .0550837        .1321556
inc |   -.4082359      .074296        -.482532        1.006408
------------------------------------------------------------------------------
                     b = consistent under Ho and Ha; obtained from xtpmg
          B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        6.88
                Prob>chi2 =      0.2297
```

.
.
.
. xtpmgd.ginid.fdid.pse d.inf d.fd d.inc, lr(l.ginifdipse inf fdinc) ec(ECT) replace mg

```
-------------------------------------------------------------------------------
Mean Group Estimation: Error Correction Form
(Estimate results saved as mg)
-------------------------------------------------------------------------------
-------------------------------------------------------------------------------
D.gini |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+-----------------------------------------------------------------
ECT          |
fdi|  -.0053225   .0044371    -1.20   0.230    -.0140191    .0033741
pse |   .0002868   .0002345     1.22   0.221    -.0001728    .0007464
        inf |   .0003618   .0004661     0.78   0.438    -.0005517    .0012754
fd |   .0024158   .0026021     0.93   0.353    -.0026842    .0075158
inc|  -.0035072    .015131    -0.23   0.817    -.0331635    .0261491
```

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```
-------------+----------------------------------------------------------------
SR           |
         ECT | -.1248823   .0549939    -2.27   0.023    -.2326683   -.0170962
             |
fdi          |
         D1. |  .0002606   .0001406     1.85   0.064     -.000015    .0005363
             |
pse          |
         D1. |  4.00e-07   .0000208     0.02   0.985    -.0000404    .0000412
             |
         inf |
         D1. | -.0000115   .0000326    -0.35   0.724    -.0000755    .0000524
             |
fd           |
         D1. |  .0002682   .0001961     1.37   0.171    -.0001161    .0006526
             |
inc          |
         D1. | -.0005421   .0014559    -0.37   0.710    -.0033956    .0023113
             |
       _cons |  .0033117   .0102175     0.32   0.746    -.0167143    .0233376
------------------------------------------------------------------------------
```

```
.
. xtpmgd.ginid.fdid.pse d.inf d.fd d.inc, lr(l.ginifdipse inf fdinc) ec(ECT) replace pmg

Iteration 0:   log likelihood =  1714.5781  (not concave)
Iteration 1:   log likelihood =  1730.9425  (not concave)
Iteration 2:   log likelihood =  1736.7613  (not concave)
Iteration 3:   log likelihood =  1738.8134
Iteration 4:   log likelihood =  1739.1883  (backed up)
Iteration 5:   log likelihood =  1739.5341
Iteration 6:   log likelihood =  1739.5477
Iteration 7:   log likelihood =  1739.5477

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): c_id                Number of obs      =       341
Time Variable (t): year                 Number of groups   =        15
Obs per group: min =         19
```

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```
                                                avg =      22.7
                                                max =        23

                                  Log Likelihood    =  1739.548
------------------------------------------------------------------------------
D.gini |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
ECT          |
fdi |   .0012594   .0006409     1.96   0.049     3.16e-06    .0025156
pse|  -.0001705   .0000805    -2.12   0.034    -.0003283   -.0000127
       inf |  -.0008796   .0003919    -2.24   0.025    -.0016477   -.0001116
fd|  -.0069954   .0013717    -5.10   0.000    -.0096839   -.0043068
inc|  -.0226074   .0096925    -2.33   0.020    -.0416043   -.0036105
-------------+----------------------------------------------------------------
SR           |
       ECT |  -.0617451   .0144067    -4.31   0.000    -.1020621    .034411
           |
fdi |
       D1. |   .0000415   .0001061     0.39   0.696    -.0001664    .0002494
           |
pse |
       D1. |  -.0000147   7.85e-06    -1.87   0.061    -.0000301    6.96e-07
           |
       inf |
       D1. |  -.0000509   .0000214    -2.38   0.017    -.0000927   -9.04e-06
           |
fd |
       D1. |   .0001635    .000209     0.78   0.434    -.0002461    .0005731
           |
inc |
       D1. |   .0026286   .0019399     1.36   0.175    -.0011735    .0064307
           |
     _cons |  -.0010258   .0047914    -0.21   0.830    -.0104169    .0083652
------------------------------------------------------------------------------

.
. hausman mg pmg, sigmamore

                ---- Coefficients ----
          |      (b)          (B)          (b-B)     sqrt(diag(V_b-V_B))
```

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```
             |      mg         pmg        Difference         S.E.
-------------+------------------------------------------------------------
fdi |   -.0053225     .0012594       -.0065819        .0088034
pse |    .0002868    -.0001705        .0004573        .0004595
        inf |    .0003618    -.0008796        .0012414        .0008404
fd |    .0024158    -.0069954        .0094112        .0049912
inc |   -.0035072    -.0226074        .0191002        .0284965
------------------------------------------------------------------------------
                    b = consistent under Ho and Ha; obtained from xtpmg
         B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

   Test:  Ho:  difference in coefficients not systematic

                chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                      =      4.6447
              Prob>chi2 =      0.3520
```

Objective 3

```
Notes:
     1.  Unicode is supported; see help unicode_advice.
     2.  Maximum number of variables is set to 5000; see help set_maxvar.

. *(17 variables, 360 observations pasted into data editor)

. xtsetc_id year
      panel variable:  c_id (strongly balanced)
       time variable:  year, 1996 to 2019
               delta:  1 unit

. xtpmgd.gini d.co2 d.inc d.pse d.inf d.fd, lr(l.gini co2 incpse inf fd) ec(ECT) replace mg

------------------------------------------------------------------------------
Mean Group Estimation: Error Correction Form
(Estimate results saved as mg)
------------------------------------------------------------------------------
------------------------------------------------------------------------------
D.gini |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
```

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```
ECT          |
       co2 |   .0029758   .0658987     0.05   0.964    -.1261832    .1321348
inc|  -.0213369   .0213094    -1.00   0.317    -.0631026    .0204287
pse |   .0003224   .0002698     1.19   0.232    -.0002065    .0008512
       inf |  -.0013243   .0010714    -1.24   0.216    -.0034243    .0007756
fd |   .0004609   .0022483     0.20   0.838    -.0039458    .0048675
-------------+----------------------------------------------------------------
SR           |
       ECT |  -.1406811   .0447398    -3.14   0.002    -.2283695   -.0529927
           |
       co2 |
       D1. |   .0003971   .0013875     0.29   0.775    -.0023223    .0031166
           |
inc |
       D1. |  -.0007128   .0014832    -0.48   0.631    -.0036199    .0021943
           |
pse |
       D1. |   .0000327   .0000326     1.00   0.316    -.0000313    .0000966
           |
       inf |
       D1. |   .0000387   .0000359     1.08   0.281    -.0000316     .000109
           |
fd |
       D1. |   .0001713   .0001295     1.32   0.186    -.0000824    .0004251
           |
     _cons |   .0035356   .0159022     0.22   0.824    -.0276321    .0347033
------------------------------------------------------------------------------

.
. xtpmgd.gini d.co2 d.inc d.pse d.inf d.fd, lr(l.gini co2 incpse inf fd) ec(ECT) replace pmg

Iteration 0:   log likelihood =   1691.651  (not concave)
Iteration 1:   log likelihood =  1707.8056  (not concave)
Iteration 2:   log likelihood =  1708.4132  (not concave)
Iteration 3:   log likelihood =  1713.7276  (not concave)
Iteration 4:   log likelihood =  1722.1239  (not concave)
Iteration 5:   log likelihood =  1725.1357
Iteration 6:   log likelihood =  1725.5667
Iteration 7:   log likelihood =  1727.5629
Iteration 8:   log likelihood =  1728.3726
```

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Iteration 9: log likelihood = 1728.395
Iteration 10: log likelihood = 1728.3951

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): c_id Number of obs = 337
Time Variable (t): year Number of groups = 15
Obs per group: min = 19
avg = 22.5
max = 23

Log Likelihood = 1728.395

D.gini	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ECT						
co2	-.0574699	.0097328	-5.90	0.000	-.0765459	-.0383939
inc	.0196744	.0049475	3.98	0.000	.0099775	.0293714
pse	-.0001181	.000042	-2.81	0.005	-.0002004	-.0000358
inf	-.0007214	.0002861	-2.52	0.012	-.0012821	-.0001606
fd	.0015944	.0003463	4.60	0.000	.0009156	.0022732
SR						
ECT	-.0421401	.0172504	-2.44	0.015	-.0759502	-.00833
co2						
D1.	.0016022	.0017803	0.90	0.368	-.0018872	.0050915
inc						
D1.	.0014394	.001568	0.92	0.359	-.0016337	.0045125
pse						
D1.	-7.49e-06	5.16e-06	-1.45	0.146	-.0000176	2.62e-06
inf						
D1.	-.0000303	.0000255	-1.19	0.235	-.0000803	.0000197
fd						
D1.	.000118	.0001859	0.63	0.526	-.0002463	.0004823

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```
           |
      _cons |  -.0028642   .0016311    -1.76   0.079    -.0060612    .0003327
------------------------------------------------------------------------------

.
. hausman mg pmg, sigmamore

                ---- Coefficients ----
             |      (b)          (B)          (b-B)     sqrt(diag(V_b-V_B))
             |       mg          pmg         Difference          S.E.
-------------+----------------------------------------------------------------
         co2 |    .0029758    -.0574699        .0604457        .1877386
inc |   -.0213369     .0196744       -.0410114        .0605882
pse |    .0003224    -.0001181        .0004404        .0007686
         inf |   -.0013243    -.0007214       -.000603         .003043
fd |    .0004609     .0015944       -.0011336        .0064045
------------------------------------------------------------------------------
                     b = consistent under Ho and Ha; obtained from xtpmg
          B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        1.32
                Prob>chi2 =      0.9328

.
.
.
. xtpmgd.ginid.ecft d.inc d.pse d.inf d.fd, lr(l.giniecftincpse inf fd) ec(ECT) replace mg
Maximum number of iterations exceeded.
r(498);

.
. xtpmgd.ginid.ecft d.inc d.pse d.inf d.fd, lr(l.giniecftincpse inf fd) ec(ECT) replace pmg

Iteration 0:   log likelihood =  1703.6595  (not concave)
Iteration 1:   log likelihood =  1716.3053  (not concave)
Iteration 2:   log likelihood =   1719.141
Iteration 3:   log likelihood =  1720.6721
```

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Iteration 4: log likelihood = 1720.7732
Iteration 5: log likelihood = 1720.774
Iteration 6: log likelihood = 1720.774

Pooled Mean Group Regression
(Estimate results saved as pmg)

Panel Variable (i): c_id Number of obs = 341
Time Variable (t): year Number of groups = 15
Obs per group: min = 19
avg = 22.7
max = 23

Log Likelihood = 1720.774

D.gini	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
ECT						
ecft	-.1515703	.0251994	-6.01	0.000	-.2009603	-.1021803
inc	.02568	.0054906	4.68	0.000	.0149186	.0364415
pse	-.0001071	.0000443	-2.42	0.015	-.0001939	-.0000204
inf	-.0004064	.0003025	-1.34	0.179	-.0009992	.0001864
fd	.0005436	.0005407	1.01	0.315	-.0005162	.0016034
SR						
ECT	-.2911251	.0161594	-18.0	0.000	-.0607844	.0025593
ecft						
D1.	.0036195	.0022635	1.60	0.110	-.0008169	.0080558
inc						
D1.	.0030564	.0017643	1.73	0.083	-.0004016	.0065144
pse						
D1.	7.02e-06	.0000108	0.65	0.516	-.0000142	.0000282
inf						
D1.	-.0000647	.0000239	-2.71	0.007	-.0001115	-.0000178
fd						

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```
       D1. |   .0001343   .0001893     0.71   0.478    -.0002366    .0005053
           |
     _cons |   .0007611   .0006795     1.12   0.263    -.0005707    .0020928
------------------------------------------------------------------------------

.
. hausman mg pmg, sigmamore

                ---- Coefficients ----
          |      (b)          (B)          (b-B)     sqrt(diag(V_b-V_B))
          |       mg          pmg         Difference          S.E.
-------------+----------------------------------------------------------------
inc |   -.0213369       .02568       -.047017        .0684499
pse |    .0003224    -.0001071        .0004295        .0008684
        inf |   -.0013243    -.0004064       -.0009179        .0034393
fd |    .0004609     .0005436       -.0000827         .007225
------------------------------------------------------------------------------
                     b = consistent under Ho and Ha; obtained from xtpmg
          B = inconsistent under Ha, efficient under Ho; obtained from xtpmg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =        0.88
                Prob>chi2 =      0.9272
```

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